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THESIS

MONITORING THE PERFORMANCE OF IWS PROCESSES IN AN OPEN ARCHITECTURE ENVIRONMENT

by

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March 2008

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MONITORING THE PERFORMANCE OF IWS PROCESSES IN AN OPEN ARCHITECTURE ENVIRONMENT

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ABSTRACT

This thesis focuses on a trial implementation of Knowledge Value Added (KVA) software supporting the management of an Open Architecture (OA) process performance monitoring analysis. During this research Maritime Domain Awareness (MDA) business processes establish the baseline Return On Investment (ROI) analysis. Trial implementation of KVA software tools focus on the assessing and monitoring performance of OA. Installation of KVA software tools are used to support ongoing assessment and performance monitoring for Integrated Weapons System (IWS) OA management. This work illustrates the capability to perform ongoing ROI analysis on OA processes for development and acquisition processes enabled through the use of the OA approach. Included in management reports derived from the GaussSoft KVA software, a crucial output of this thesis is the ability of the organization to extend the use of the method and toolset over time to meet ongoing needs of Program Executive Office (PEO) - IWS from MDA into other programs/systems. All data gathered was conducted in the UNCLASSIFIED environment for use in this research.

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TABLE OF CONTENTS

LIST OF FIGURES

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LIST OF TABLES

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LIST OF ABBREVIATIONS, ACRONYMS AND SYMBOLS

ABB: Activity Based Budgeting

ABC: Activity Based Costing

ABM: Activity Based Management

AOR: Area of Responsibility

BFC: Biometric Fusion Center

BGAN: Broadband Global Area Network

BI: Business Intelligence

BPM: Business Performance Management

BT: Boarding Team

BWC: Battle Watch Captain

C2: Command & Control

C7F: Commander US 7^{th} Fleet

CAT: Crisis Action Teams

CCOP: Cryptographic Carry-On Program

CDR: Commander

CENTRIXS: Coalition (Combined) Enterprise Information Exchange System

CG: Coast Guard

CHAT: Conversational Hypertext Access Technology

CIFC: Coalition Intel Fusion Center

CIP: Common Intelligence Picture

CMA: Comprehensive Maritime Awareness

CMFP: Cooperative Maritime Forces Pacific (CENTRIXS enclave)

CNFC Chat/Email: Cooperative Naval Forces CENTCOM (CENTRIXS enclave)

CoA: Course of Action

COC: Chain Of Command

COCOM: Combatant Command

COI: Contact of Interest

CoP: Common Operating Picture

COPS: Current Operations (Current Operations Cell in MOC)

COTS: Commercial Off The Shelf

CTF: Commander, Task Force

DHS: Department of Homeland Security

DIW: Dead In Water

DoD: Department of Defense

EMIO: Expanded Maritime Interception Operations

EVA: Economic Value Added

FO: Forward Observer

FOPS: Future Operations

HOA MOC: Horn of Africa Maritime Operations Center

ICC: International Chamber of Commerce

IMB: International Maritime Bureau

IO: Intelligence Officer

ISR: Intelligence, Surveillance, & Reconnaissance

IT: Information Technology

IW: Information Warfare

IWO: Intelligence Watch Officer

IWS: Integrated Warfare Sytems

JWICS/SIPR: Joint Worldwide Intelligence Communications System; Secure Internet Protocol Router

KVA: Knowledge Value Added

KVA+RO: Knowledge Value Added and Real Options

LINX-NCIS: Law Enforcement Information Exchange-Navy Criminal Investigative Service

MARLO: Maritime Liaison Office

MDA: Maritime Domain Awareness

MDP: Maritime Domain Protection

MHQ: Maritime Headquarters

MIC: MIO Commander

MIO: Maritime Interception Operations (Also: Maritime Interdiction Operations)

MOC: Maritime Operations Center

MOTR: National Maritime Operation Threat Response

MTAC: Multiple Threat Alert Center

N2: Intelligence Officer

NAVCENT: U.S. Naval Forces Central Command

NMIC: Naval Maritime Intelligence Center

NSPD: National Security Presidential Directive

OA: Open Architecture

OACE: Open Architecture Computing Environment

ONA: Operational Net Assessment

ONI: Office of Naval Intelligence

OODA: Observe, Orient, Decide, & Act

OPG: Operational Planning Group

OPNAV: Office of the Chief of Naval Operations

OSC: On-Scene Commander

P&L: Profit & Loss

PEO IWS: Program Executive Office, Integrated Warfare Systems

RDC: Rapid Deployment Capability

Rel 4: Releasable 4-eyes (US/CAN/UK/AUS)

RFI: Request For Information

RHIB: Rigid Hull Inflatable Boat

ROA: Return On Asset

ROI: Return on Investment

ROK: Return on Knowledge

SAS: Statistical Analysis Software Institute

SATCOM: Satellite Communication

SEAPORT: ONI Database

SecDef: Secretary of Defense

SIPRNET: Secret Internet Protocol Router Network

SME: Subject Matter Expert

SPIRAL 1: First time around of execution of effort

SSDS: Ship Self Defense System

TAANDEM: Track Assessment and Anomaly Detection--Maritime

TLT: Total Learning Time

TRIPWIRE: A tool used for change audition and configuration assessment

UK MTO: United Kingdom Maritime Tasking Order

UNCLAS: Unclassified

UNSC: United Nations Security Council

USCG: United States Coast Guard

VBSS: Visit, Board, Search, & Seizure

VOI: Vessel of Interest

WO: Watch Officer

WV: West Virginia

YEM CG: Yemeni Coast Guard

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I. INTRODUCTION

A. PURPOSE

There is an expanding need to improve decision-making processes and coordinated joint and coalition efforts within the workflow processes of the Maritime Domain Awareness (MDA) environment. This system continues to be modeled and researched for logically feasible and economical solutions for the purpose of identifying gaps in MDA capability and proficiency and enhancing them as directed by *The National Strategy for Maritime Security (September 2005)*. Technology of today may hold the key to unlocking a plethora of relevant, timely, and cost effective information collecting solutions, which will provide forces within the MDA environment with relevant knowledge as compared to our enemies. Such a technology explored within this thesis is a complete Knowledge Value Added (KVA) software solution that provides continuous near real-time data collection and provides the user with an indication of the value produced within the MDA "As Is" model. This model and its processes will be analyzed to assess whether it possesses an efficient system design, and whether it provides flexibility, capability, and adaptability which satisfy the requirements of an MDA environment through open architecture (OA).

With OA being an approach system designers use to address economic and technological issues within MDA processes, it is an efficient approach for innovation OA provides relief in regards to efforts of efficiency, cost effectiveness, speed and flexibility on behalf of military personnel within the MDA environment. Overall, the implementation of KVA software within the MDA's "As Is" process flow will reveal the value added and return on investment (ROI), as a metric tool from which decision makers can leverage military power, mitigate operational risk, and project military force via an advantage in knowledge superiority which is both timely and relevant.

B. BACKGROUND/LITERARY REVIEW

MDA is concerned with maintaining a worldwide common intelligence picture (CIP) of maritime traffic via a distributed network of intelligence, surveillance, and reconnaissance (ISR) systems. MDA supports Maritime Domain Protection (MDP), which involves the use of MDA to safeguard the security of the U.S. and its allies.

> MDA spans dozens of issues – from missile defense and counterterrorism to cargo and container security, from drug trafficking and immigration to fishing rights and search and rescue. [1]

Numerous government and non-government entities are participating in MDA. Within the United States, the MDA effort has to date been spearheaded by the Department of Homeland Security, the U.S. Coast Guard, and the U.S. Navy. MDA is an ongoing project aimed at solving the complex problems defined throughout the following sections.

A previous study conducted at the Naval Postgraduate School by Capt. Joseph Uchytil, "*Assessing the Operational Value of Situational Awareness of AEGIS and Ship Self-Defense System (SSDS) Platforms through the Application of the Knowledge Value Added (KVA) Methodology,*" demonstrated that KVA could be used to estimate the performance of an OA implementation in terms of a Return on Investment (ROI).[2] While Capt. Uchytil's research focused on benefits derived from the warfighter's perspective, the purpose of this research is to implement KVA software and assess the KVA and ROI of the MDA "As Is" process flow using OA.

Lieutenant Ira D. Lambeth, III and Lieutenant Hubert N. Clapp's research, "*Using Knowledge Value Added (KVA) For Evaluating Cryptologic IT Capabilities: Trial Implementation,*" provided a methodology by which program managers can make informed investment decisions by measuring performance metrics of technology

[1] Johns Hopkins University Applied Physics Laboratory Web Site. Available from http://www.jhuapl.edu/newscenter/aplnews/2004/summer_mda.asp (Accessed 29 February 2008).

[2] Uchytil, J., "Assessing the Operational Value of Situational Awareness for AEGIS and Ship Self-Defense System (SSDS) Platforms through the Application of the Knowledge Value-Added (KVA) Methodology," Master of Science in Information Technology Management, Naval Postgraduate School, 2006 (Accessed 29 February 2008).

embedded in core processes. They used real-world data from afloat cryptologic systems to show how this decision support model can be developed to assist in the Program Objective Memorandum (POM)/Budgeting process for Office of the Chief of Naval Operations (OPNAV) N20's acquisition of Information Warfare (IW) systems. Utilizing the KVA methodology and market comparables, they were able to estimate surrogate revenue pricing to enable an estimate of ROI for each Cryptographic Carry-On Program (CCOP) using GaussSoft KVA Performance Accounting Modeling Software to analyze and model ROI data and a near real-time operational model.[3] During this research, GaussSoft KVA Performance Accounting Modeling Software will be used to analyze and model ROI data using a near real-time operational model (MDA "As Is" process flow model).

Another Naval Postgraduate School study was conducted by Lieutenant Christopher J. Goodson and Lieutenant Richard D. Knutson, *"Portfolio Management Decision Support Tools Analysis Relating to Management Value Metrics."* Their research covered MDA aspects of the ship tracking process in prevention and interdiction functions. The purpose of their research was to demonstrate that the KVA methodology can be used to assess current performance of core MDA processes. This type of approach aimed to help identify and value MDA processes. The results of their research focused on assisting MDA managers and operational leaders make portfolio management decisions for allocating resources and creating the correct support tools for MDA processes and support systems. Their research provided a "proof of concept" test of a set of decision support tools to support managers in the MDA ship tracking process, and also explored a new methodology for determining the value added by management to the process.

Goodson and Knutson's proof of concept study demonstrated their research approach can be used to value changes through automation to the MDA process of track generation. Track generation is the process of determining the track or tracks of detected objects. It is usually a three step process of data association, track initialization, and track

[3] Johns Hopkins University Applied Physics Laboratory Web Site. Available from http://www.jhuapl.edu/newscenter/aplnews/2004/summer_mda.asp (Accessed 29 February 2008).

improvement filtering. Their research can help top level management make portfolio management decisions for allocating resources for MDA information systems or reallocation based on the ability to exercise the most beneficial option for the organization. Track generation automation helps provide the following improvements:

- Faster track generation of a Maritime Contact of Interest (COI)
- Provide the opportunity to improve fleet Maritime Interdiction Operations (MIO) intelligence gathering
- Decrease personnel costs by reducing the number of MDA watch standers
- Improve productivity in current MDA processes, allowing more U.S. Navy and U.S. Coast Guard ship boarding

This new track generation automation will help provide increased value in MDA. The technology implementation presents a great opportunity for the Department of Homeland Security, U.S. Coast Guard, and U.S. Navy to maintain their fight on the Global War on Terrorism when conducting Maritime Interdiction Operations (MIO) during peacetime and wartime as the threat of terrorism becomes more unpredictable. [4]

As a follow-on thesis to LT Christopher J. Goodson and LT Richard D. Knutson's research, my thesis, similar to all other previously mentioned theses, is conducted at the Naval Postgraduate School and focuses on a trial implementation of KVA software to support management of OA process performance monitoring and analysis. During this research, KVA software will be used to capture and assess the KVA of the MDA "As Is" workflow model, in particular its decision making processes. This will be a proof of concept trial implementation to establish the baseline ROI analysis using the GaussSoft KVA tool.

[4] Goodson, C. and Knutson, R. "Portfolio Management Decision Support Tools Analysis Relating To Management Value Metrics," Monterey, CA: Naval Postgraduate School, 2007. p. 29.

C. RESEARCH OBJECTIVES

The objective of this research is to analyze the potential benefits of OA from the PEO IWS perspective in the MDA "As Is" process flow, using a KVA software solution. This will be achieved through an approach using KVA which will provide an analytical framework to assess the value added of the OA approach to MDA decision-making "As Is" process model. Refer to Chapter III for a more detailed description of the KVA methodology.

D. RESEARCH QUESTIONS

This thesis will provide an analysis of an MDA process flow "As-Is" model for using open architecture to meet the current and future demands and challenges of MDA.

This analysis will address the following research questions:

- What can be gleaned from collecting performance data on an ongoing basis that would be valuable to the MDA process flow?
- While using OA, what portion of the MDA "As Is" workflow model provides the best means of employing MDA knowledge assets based on their performance?
- What is the baseline measurement of KVA and ROI of the MDA "As Is" workflow model?
- Are people and equipment being used in such a manner as to maximize output efficiency and performance?

This research will provide decision makers with a structured analysis of employing OA to establish a baseline measure of KVA and ROI within the MDA "As Is" workflow process.

E. METHODOLOGY

This thesis will attempt to implement KVA software within MDA “As Is” process flow models to reveal value added and ROI. The results will provide a metric tool from which decision makers can leverage military power, by gaining comprehension of heir knowledge assets as resources.

This will serve as a baseline analysis to compare against the “To Be” model in future research. This analysis will be conducted using MDA process subject matter experts. The KVA analysis associated with the “As Is” (employing an OA framework) system will produce an ROI for each process model. The ROI associated with this process model will thus determine the KVA of the MDA workflow process. Recommendations will be made for follow-on research at the conclusion of this thesis.

F. THESIS ORGANIZATION

Chapter organization will be as follows: Chapter I will give a general overview of the purpose, background, research objectives, research questions, and intended methods and scope of this thesis. Chapter II will provide information on MDA. Chapter III will provide information on KVA. Chapter IV will provide information on KVA software. Chapter V will provide information on OA. Chapter VI will discuss the case study method and discuss the results from the KVA analysis and the implications of the current “As Is” state of the MDA workflow process model, and then explore the analysis results. Chapter VII will present conclusions from the research that was conducted. Chapter VIII will recommend further research that can be conducted to continue the process of refining the MDA workflow process model within the context of OA in the fleet.

II. MARITIME DOMAIN AWARENESS

A. MARITIME DOMAIN AWARENESS

In order to visualize the vast concept of this subject matter as one within a more narrowed scope, defining terms that will be widely used is necessary. A few of these key terms are maritime domain, maritime domain awareness (MDA), and maritime interception operations (MIO). Maritime domain, as defined in Joint Publication 3-32, consists of the oceans, seas, bays, estuaries, islands, coastal areas, and the airspace above these, including the littorals. Essentially, this covers every navigable body of water capable of being exploited in manners contrary to U.S. interests. MDA, which is also defined in Joint Publication 3-32, is the effective understanding of anything associated with the maritime domain that could impact the security, safety, economy, or environment of a nation.[5] Therefore, as U.S. naval and coalition forces work toward better ways to mitigate use of the maritime domain by enemies for illegal purposes, it is important to improve capabilities and technology as well as learning to tap into the resources of knowledge assets.

MDA vastly spans dozens of issues, from missile defense and counterterrorism to cargo and container security, from drug trafficking and immigration to fishing rights and search and rescue.[6] All of these maritime domain issues are, to say the least, major undertakings in and of themselves. MDA aims to increase our global awareness and knowledge of what transpires in the maritime domain. Achieving that end requires continuous effort to collect data on vessels' crew and passenger names, as well as their cargo. Data collection is essential and must be accurate. This accuracy provides a filter for distinguishing between law-abiding entities and unusual threats within an MDA environment.

[5] Joint Publication 3-32. Command and Control for Joint Maritime Operations, August 8, 2006. p. GL-8.

[6] Johns Hopkins University Applied Physics Laboratory Web Site. Available from http://www.jhuapl.edu/newscenter/aplnews/2004/summer_mda.asp (Accessed 29 February 2008).

The *National Plan to Achieve Maritime Domain Awareness* is a strategy to successfully implement the security plans tasked in the National Security Presidential Directive (NSPD)-41/HSPD-13. This strategy directs unification efforts of the U.S. across the federal government, the private sector and civil authorities within the U.S., and its allies and partners to globally achieve MDA. Collaboration to attain MDA is an approach that capitalizes on increased human and information technology (IT) assets; therefore realizing the value added by OA as the conduit for proliferation of near real-time information sharing. With effective information sharing and collaborating among MDA entities, contribution of each knowledge asset is thereby force-multiplied creating a situation where the whole is greater than the sum of its parts.

The MDA “As Is” workflow model is structured like John Boyd’s well known Observe, Orient, Decide, and Act (OODA) Loop, where an entity (either an individual or an organization) that can process this cycle quickly, observing and reacting to unfolding events more rapidly than an opponent, can thereby "get inside" the opponent's decision cycle and gain a military. OA provides the means that human and IT assets optimize decision making time, vessels of interest searching time, and vulnerability awareness from water borne threats. By collecting continuous and accurate data shared across assets and tracking vessel status, the process of identifying and differentiating lawful and legitimate traffic can be promptly executed; thus making a filtering mechanism based on current and historical data.

B. MARITIME DOMAIN AWARENESS AT NPS

The Naval Postgraduate School has launched a Maritime Domain Awareness initiative that is focused on possible courses of action with regards to maritime terrorism. Numerous research projects are underway at NPS including Command and Control, Port Security and Infrastructure, data tagging, data fusion, systems design, and multi-level security. This thesis addresses the issues of feasibly using KVA software to assess the benefits, or ROI, in the OA of an MDA environment in the context of a VBSS “As Is” workflow model.

C. MARITIME INTERCEPTION OPERATIONS

Maritime Interception Operations (MIO) is defined as, "the legitimate action of denying suspect vessels access to specific ports for import or export of prohibited goods to or from a specified nation or nations, for purposes of peacekeeping or to enforce imposed sanctions."[7] MIO is the act of intercepting or interdicting suspect vessels to determine if they are transporting goods or persons prohibited by the sanctioning agency to or from a specific nation, nations, or non-state sponsored organizations. Action taken during MIO may include the following:[8]

1. Sending armed boarding parties to visit merchant ships bound to, through, or out of a defined area.
2. Examining each ship's papers and cargo.
3. Searching for evidence of contraband.
4. Diverting vessels failing to comply with the guidelines set forth by the sanctioning body.
5. Seizing suspect vessels and their cargo that refuse to divert.

MIO is based on international law and conducted under authorization from the Secretary of Defense (SecDef) after Presidential approval. OA enables assets in the MDA "As Is" workflow model collect data via intelligence, surveillance, and reconnaissance (ISR). Real-time and near-real-time ISR are vital prior to and during maritime operations to support specific MIO missions. When an operation warrants, the MIO Commander (MIC) intelligence officer (IO) ensures optimum ISR support. The use of Conversational Hypertext Access Technology (CHAT) and other collaboration knowledge assets and communications tools are also critical to MIO.[9]

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[7] NTTP 3-07.11, *Maritime Interception Operations*, November 2003. p. 1-5.

[8] Center for Security Forces (CENSECFOR),"Trainee Guide for Visit, Board, Search and Seizure (VBSS) Boarding Officer (BO) A-2E-0085 (Rev C)," Center for Security Forces (CENSECFOR), February, 2007. p. 12.

[9] Ibid., p. 3-1.

Operational use of computers, computer networks, and automatic data processing equipment is mission essential for conducting MIO. Fast, secure reporting, and the exchange of text and graphic images between the On-Scene Commander (OSC), MIC, and fleet operations centers depends on Secret Internet Protocol Router Network (SIPRNET) connectivity. The capability of data linking real-time and near real- time images throughout the MIO "Chain of Command" (COC) rapidly provides situational awareness, detailed information, and data that supports both the reporting and decision-making processes. It also allows intelligence information to be shared quickly and accurately with other agencies such as the Office of Naval Intelligence (ONI), and United Nations Security Council (UNSC).[10]

In support of the MIO mission, MIO is conducted in three phases that embody the concepts of the OODA Loop also designed in within the MDA "As Is" workflow model in Chapter 6 Figure 14.[11] The three phases of MIO each correspond to the stages of the OODA Loop, Phase 1-Detection and Surveillance, Phase 2-Query, Approach and Stopping, and Phase 3-Boarding and Searching correspond to Observe & Orient, Decide, and Act respectively.

1. Phase One: Detection and Surveillance (Observe & Orient)

Phase one involves identifying and tracking motor vessels, and providing near real-time contact information to the MIO commander. Contact information for the overall operation is maintained by the MIO commander within the master contact database and updated per contact interception and or boarding report. The master contact database can assist in filtering motor vessel traffic based on historical data if the vessel has been previously screened via boarding process or intelligence from collaborating asset sources allowing expeditious execution through the OODA Loop.

[10] NTTP 3-07.11, *Maritime Interception Operations*, November 2003. p 3-2.

[11] ATP-71, *Allied Maritime Interdiction Operations*, April 2005. pp. 3-1 to 5-20.

2. Phase Two: Query, Approach, and Stopping (Decide)

Phase two involves two types of queries, an approach procedure, and stopping a motor vessel for boarding. The initial query is conducted via Bridge-to-Bridge radio communications to determine if a boarding will be required. Subsequent queries are conducted if the MIO commander orders a boarding and is used to inform the motor vessel of the intent to board, solicit vessel information, and convey instructions. Approach is a procedure for a boarding vessel or boarding vessel and assists ship to maneuver within close proximity to the motor vessel for VBSS; therefore can either be a single ship or dual ship operation respectfully. Stopping means anything between "Dead in Water" (DIW) to slowing to bare steerage way to support small boat operations.

3. Phase Three: Boarding and Searching (Act)

Phase three involves Boarding and Searching, is where VBSS takes place, and is the most important and hazardous phase of MIO.

D. VISIT, BOARD, SEARCH, AND SEIZURE

Visit, Board, Search, and Seizure (VBSS) are procedures by which U.S. forces conduct MIO in order to determine the true character of enemy or neutral vessels, cargo, and passengers.[12] Warships are not subject to visit and search. OA technologies enable the VBSS Boarding Team (BT) to collect and transmit biometric data and photographs, and receive information pertinent to screening motor vessel crew and cargo. Decision making aided by this technology within the MDA "As Is" workflow model is performed more quickly meaning faster cycling through the OODA Loop.

VBSS is a capability that goes well beyond the requirements of a search and inspection of suspect vessels by BTs. The MIO mission demands coordination and teamwork among all ship's departments to detect, track, query, and evaluate suspect vessels of all types and dimensions, to man weapons stations, operate small boats and helicopters, and provide for own ship's self-defense and security in order to effectively

[12] NTTP 3-07.11, *Maritime Interception Operations*, November 2003. p. 1-5.

employ the BT.[13] In Chapter III, this thesis will discuss providing a method for measuring the value added by the knowledge assets of MDA via the KVA and its related framework's concepts.

[13] NTTP 3-07.11, *Maritime Interception Operations*, November 2003. p. 2-6.

III. KNOWLEDGE VALUE ADDED

A. INTRODUCTION

This chapter will describe the concept of knowledge value added, which is a technique used to assess the value of knowledge assets within organizations. This technique will be used to determine the value added to the MDA "As Is" workflow model, which is the focus of this thesis.

B. KNOWLEDGE VALUE ADDED

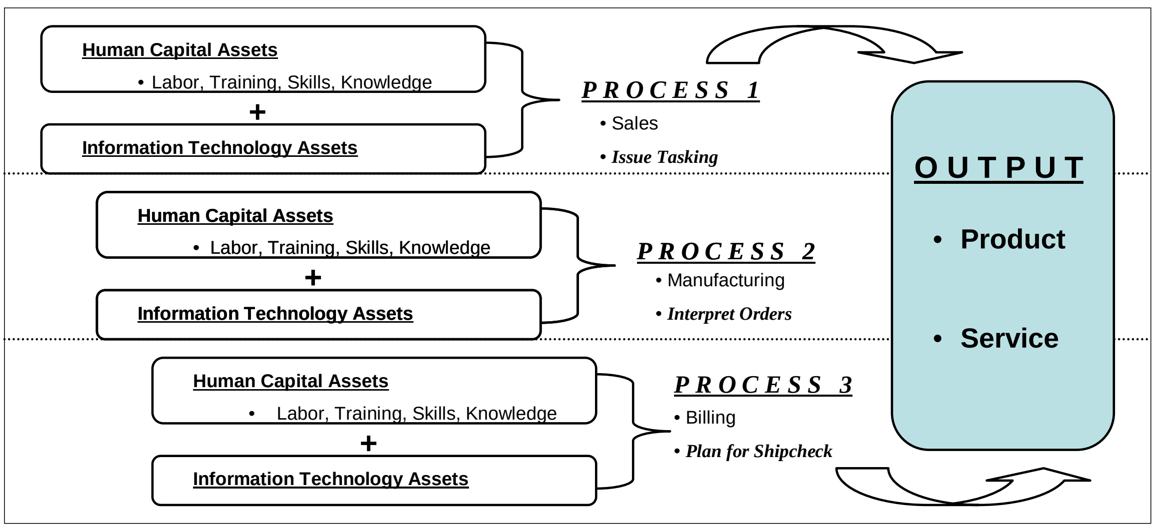
Knowledge Value Added (KVA) theory created by Dr. Tom Housel (Naval Postgraduate School) and Dr. Valery Kanevsky (Agilent Labs), addresses a need by executives and managers to leverage and measure the knowledge resident in employees, information technology, and core processes. It is a theory based on the assumption that humans and technology in organizations add value to organizations by taking inputs and converting them into outputs through core processes.[14] KVA analysis produces a return on knowledge (ROK) ratio, which estimates the value added by given knowledge assets regardless of where within an organizational process they are located.

Core business processes of organizations are a culmination of human and IT knowledge assets, which can be translated into numerical form to quantify the estimated value of change that occurs on the input during conversion to the resulting output. Figure 1 illustrates the combination of inputs from human and IT knowledge assets which contribute in the production of an organization's overall output. Such is the case for the core business processes of the MDA "As Is" workflow of this thesis through use of the KVA method. In other words, analyzing the MDA "As Is" workflow process to determine an estimate of the value of knowledge generated requires auditing the core business processes.

[14] Housel, T. and Bell, A., *Measuring and Managing Knowledge*, 1st Ed. New York City: McGraw Hill, 2001. pp. 92-93.

Knowledge, defined in the context of KVA, is the "know how" required to produce process outputs. Acquiring this "know how" is proportionate to the time it takes to learn it. Intuitively, learning time is used as a quick and convenient means for quantifying knowledge. The KVA method is applicable for any company or organizational level. KVA allows managers and investors to analyze the performance of corporate knowledge assets in core processes, by observing change made on the inputs to generate outputs. This requires postulating a common unit of knowledge that can be observed in core processes and counted in terms of its monetary value and then later compared to the cost for these common units of knowledge, through the use of ratios. The common units are economic components used to form ratios derived from the revenue from ongoing operations and can be derived continuously in near real-time with the generation of new revenue.

Figure 1. Measuring Output



KVA can be delineated in seven steps, each providing an objective method for measuring and comparing the amount of value added by a given process before and after reengineering efforts. The seven-step methodology measures processes in terms of their ROK.

1. Identify the compound process and its component processes
2. Create the shortest description possible for each component process, using the same language
3. Count the number of process language “words” in the component output descriptions
4. Designate a time period long enough to capture a representative sample of the company’s final product/service outputs following common statistical sampling practices
5. Add up the total amount of K-complexity (“words”) produced by each component during the designated time period
6. Calculate the total cost to produce the output for each component
7. Compute the ROK for each component process

Total value is captured in the key metric measurement of return on investment (ROI). In fact, companies and organizations view ROI both as a goal as well as a measure of profit and asset performance. In the analysis of KVA, ROI is calculated by the “Numerator” minus the “Denominator” all divided by “Denominator.” In other words, this ratio is defined as the investment cost subtracted from revenue in the numerator all divided by the investment cost in the denominator.[15] Comparing ROIs within a process is used to determine which sub-processes are efficiently utilizing assets and which sub-processes should be changed to improve efficiency. Calculation of ROI is illustrated in Table 1 below:[16]

Table 1. ROI Calculation, as it is related to KVA

Metric	Type	Description	Calculation
Return on Investment (ROI)	Traditional investment finance ratio	Same as traditional ROI, but applied at the sub-corporate, process level	$\frac{\text{Revenue-Investment Cost}}{\text{Investment cost}}$

15 Komoroski, C. L., Housel T., Mun J., and Hom S., “Improving the Shipyard Planning Process: The KVA + Real Options Approach.” Executive Summary, Naval Postgraduate School (Accessed 29 February 2008).p. 12-15.

16 Uchytil, J., “Assessing the Operational Value of Situational Awareness for AEGIS and Ship Self-Defense System (SSDS) Platforms through the Application of the Knowledge Value-Added (KVA) Methodology,” Master of Science in Information Technology Management, Naval Postgraduate School, 2006 (Accessed 29 February 2008). p. 10.

For ROI, net operating income of an organization or business is the difference between revenue and expenses. The cost of investment is determined by comparing the company's assets from the end of the fiscal year to the beginning of the fiscal year, in order to calculate the cost of investment. Thus, a higher return, or percentage ROI, indicates a more efficient and effective use of those assets and capital.

C. RETURN ON KNOWLEDGE

Return on knowledge (ROK) is the ratio of knowledge-based revenue allocated to each core revenues compared to its corresponding knowledge-based expenses. By comparing the expenses and revenues associated with the knowledge asset, an internal hurdle rate can be computed to compare efficiency in performance of the core areas.

With each process or sub-process, there is both a cost and revenue associated with producing an output. The ROK provides a representation of how well the assets within a process are distributed in relation to one another by utilizing the costs and revenues associated with each sub-process. The ROK is calculated by dividing the "Numerator" by the "Denominator" as illustrated in Table 2 below.[17]

Table 2. ROK Calculation

Metric	Type	Description	Calculation
Return on Knowledge (ROK)	Knowledge-Based Productivity ratio	Sub-corporate, process-level performance ratio	$\frac{\text{Outputs or Benefits in Common Units}}{\text{Cost to Produce Output}}$

[17] Uchytil, J., "Assessing the Operational Value of Situational Awareness for AEGIS and Ship Self-Defense System (SSDS) Platforms through the Application of the Knowledge Value-Added (KVA) Methodology," Master of Science in Information Technology Management, Naval Postgraduate School, 2006 (Accessed 29 February 2008). p. 10.

IV. KVA SOFTWARE

A. INTRODUCTION

Knowledge Value Added can be determined for any core business process by means of hand calculation, spreadsheets, or software. The goal of this thesis is to determine KVA by means of software that calculates the KVA of the MDA "As Is" workflow continuously with near real-time results.

The Naval Postgraduate School study conducted by Lieutenant Christopher J. Goodson and Lieutenant Richard D. Knutson, *"Portfolio Management Decision Support Tools Analysis Relating to Management Value Metrics,"* covered MDA aspects of the ship tracking process in prevention and interdiction functions. The purpose of their research was to demonstrate that the KVA methodology can be used to assess current performance of core MDA processes. This type of approach aimed to help identify and value MDA processes. The results of their research focused on assisting MDA managers and operational leaders make portfolio management decisions for allocating resources and creating the correct support tools for MDA processes and support systems. Their research provided a "proof of concept" test of a set of decision support tools to support managers in the MDA ship tracking process, and also explored a new methodology for determining the value added by management to the process.

Goodson and Knutson used GaussSoft software to model the core business processes and calculate the KVA in their thesis. Likewise, in this thesis GaussSoft is the software used to model the MDA "As Is" workflow core processes to calculate KVA. The reasons for selecting the GaussSoft software, are because GaussSoft currently is easy to use, model depictions are easy to comprehend, and is rapidly gaining market share among business intelligence (BI) solutions. In addition, it is software that calculates KVA as explained in the following overview containing information provided by the company GaussSoft, information about the Statistical Analysis Software Institute (SAS), and the comparison of the two software packages.

B. GAUSSSOFT OVERVIEW

This GaussSoft overview is provided courtesy of GaussSoft, Inc. located at http://www.gausssoft.com/index_.html.

GaussSoft is a line of software created by GaussSoft, Inc., a privately held US corporation founded in 1993, with headquarters in Santa Clara, California and presence with offices and partners in North America, Europe, and Latin America.

GaussSoft delivers scalable Corporate Performance Management solutions of unrivaled price and performance. GaussSoft products enable companies of different sizes and fields, to control and reduce the cost of enterprise operations, increase profitability, improve organizational productivity, and to make better decisions, by providing unsurpassed flexibility, scalability, and ease of use.

GaussSoft's solutions are built on an integrated suite of high performance Business software for Profit and Cost Analysis, Business Intelligence – Multidimensional Query, and Activity Reporting that are smarter, scalable, function-rich, easy to use, and dramatically more powerful and affordable than competing products.

GaussSoft has installed performance intelligence solutions in over 200 enterprise and consulting companies all around the world, including telecommunications, IT, finances, manufacturing, agribusiness firms, and government organizations. They have been implemented in customer premises by leading consulting firms including Deloitte, KPMG and Price, also by other consultants, and by the customers themselves.

GaussSoft delivers Business Performance Management (BPM) Solutions, including Business Intelligence Solutions, supporting large and medium sized companies to control and reduce processes and activities costs, increase profitability, and improve organizational productivity.

GaussSoft provides a suite of business software tools with unrivalled ease of use, scalability, flexibility and price. It includes Profit and Cost Analysis (including Real Costing, Standard costing, basic ABC – Activity Based Costing, Multi-level ABC Costing, Activity Based Management – ABM, Activity Based Budgeting – ABB, Job

costing, financial analysis, cost cutting and reduction, revenue maximization and profit management), Knowledge Value Added, Time Reporting, Business Intelligence (BI - Multidimensional Query and Reporting).

The information provided by this business management suite, includes a visual-oriented and easy-to-use tool that enables end-users to build analysis reports and dashboards, without the need of IT consultants for every information request you may have. The following are visual-oriented end-user tools within GaussSoft:

1. GaussSoft Profit and Cost

This strategic business analysis solution enables companies to know which products, services, and customers are generating profits, which are not, and more importantly, why. GaussSoft Profit and Cost will provide you with a profit and loss (P&L) statement for each object you need. Using different value and costing methodologies this solution helps cost management, reduces and controls cost, increases profitability, and improves organizational productivity.

2. GaussSoft Profit and Cost with KVA

GaussSoft Profit and Cost has an optional module implementing KVA formulas and concepts to extend a Profit and Cost model to include KVA analysis or to implement a KVA model.

3. GaussSoft Activity Report

This is a tracking tool that will easily provide you with metrics and specific information about the dedication of your employees to the activities performed for projects or customers, for human resources control, project assignation control, resource management, and per-hour billing for customers and projects. Activity Report is a fast, easy and powerful tool that allows your employees to record every daily activity in less than two minutes, encouraging employee participation.

4. GaussSoft Radial Viewer

This is a Business Intelligence (BI) front-end with graphical interaction. This tool enables all End Users to create their own queries and professional looking reports from scratch -in seconds-. Figures 2 through 4 are graphical outputs of GaussSoft products.

Figure 2. GaussSoft Accumulator View for KVA Case Study.

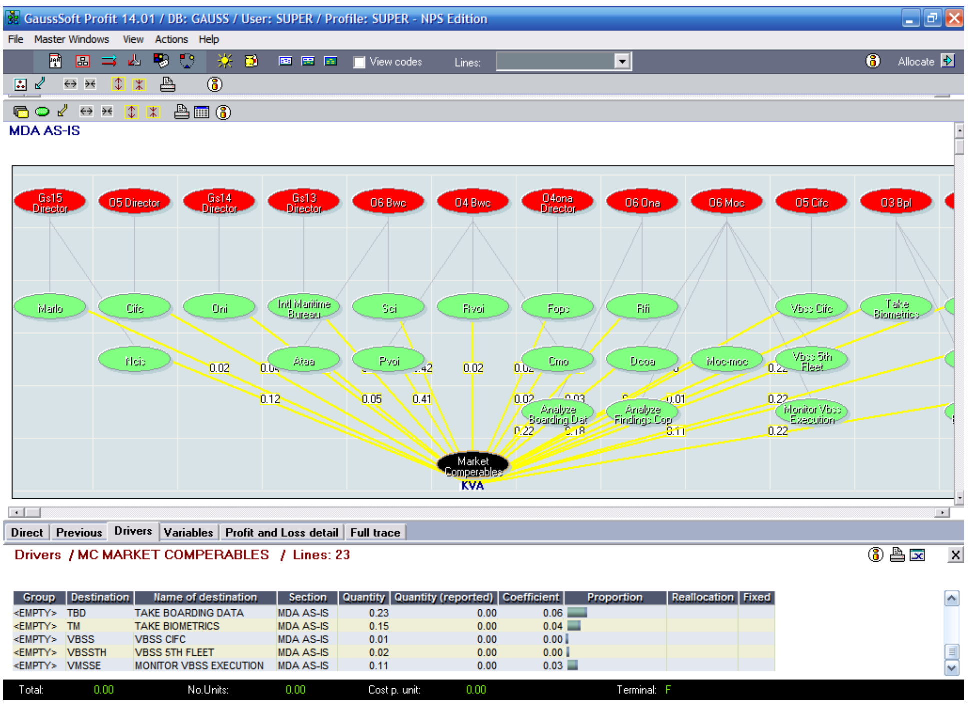


Figure 3. GaussSoft Radial Viewer Report Design Screen

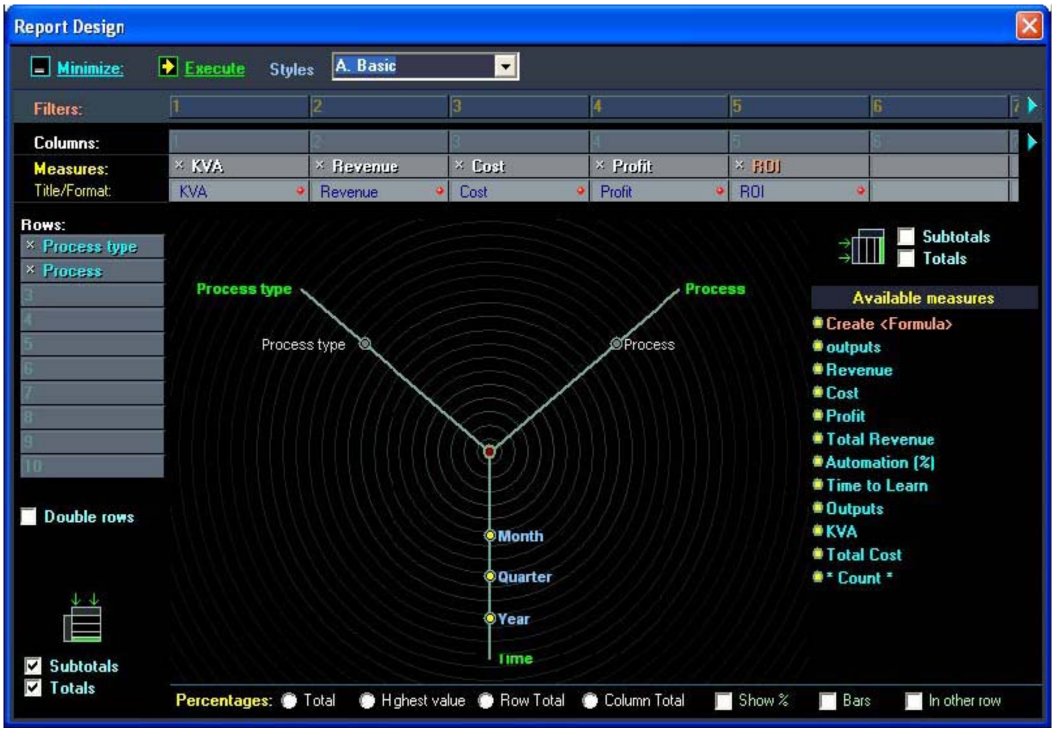
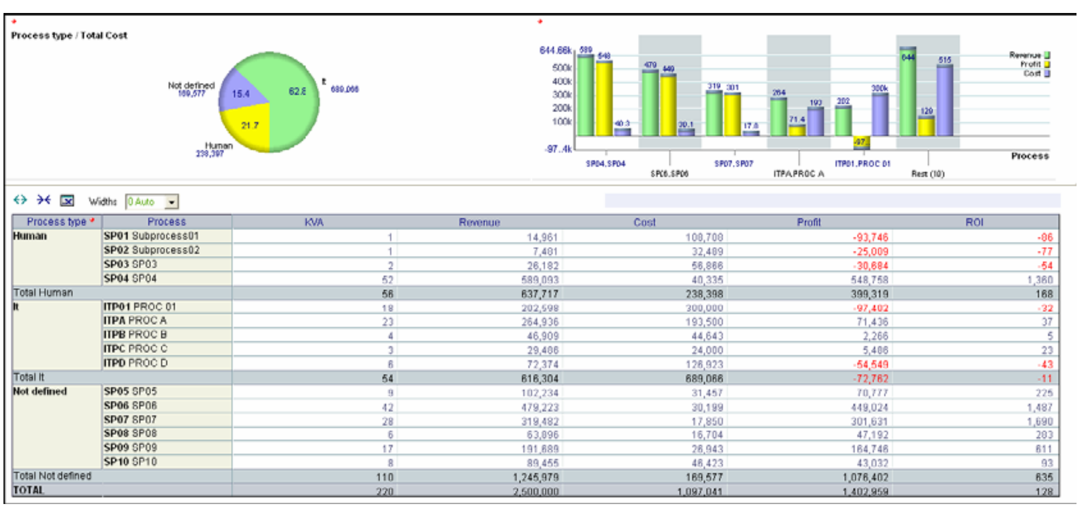


Figure 4. GaussSoft Radial Viewer Sample Report



Process type	Process	KVA	Revenue	Cost	Profit	ROI
Human	SP01 Subprocess01	1	14,961	108,700	-93,746	-86
	SP02 Subprocess02	1	7,401	32,409	-25,009	-77
	SP03 SP03	2	26,182	56,866	-30,684	-54
	SP04 SP04	52	589,093	40,335	548,758	1,360
Total Human		56	637,717	238,398	399,319	168
It	ITP01 PROC 01	18	202,598	300,000	-97,402	-32
	ITPA PROC A	23	264,936	193,500	71,436	37
	ITPB PROC B	4	46,909	44,643	2,266	5
	ITPC PROC C	3	29,406	24,000	5,406	23
	ITPD PROC D	6	72,374	126,923	-54,549	-43
Total It		54	616,304	689,066	-72,762	-11
Not defined	SP05 SP05	9	102,234	31,457	70,777	225
	SP06 SP06	42	479,223	30,199	449,024	1,487
	SP07 SP07	28	319,482	17,850	301,631	1,690
	SP08 SP08	6	63,896	16,704	47,192	283
	SP09 SP09	17	191,689	26,943	164,746	611
	SP10 SP10	8	89,455	46,423	43,032	93
Total Not defined		110	1,245,979	169,577	1,076,402	635
TOTAL		220	2,500,000	1,097,041	1,402,959	128

C. SAS OVERVIEW

This SAS overview is provided courtesy of Qualex Consulting Services Inc. and SAS Institute Inc. located at http://www.qlx.com/sas/index.html.

Founded in 1976, SAS began as a company called SAS Institute because the name SAS (by itself) was already taken by another incorporated company. SAS (pronounced sass) was an acronym for "Statistical Analysis System." SAS is a privately held software company specializing in data warehousing, information delivery and e-business solutions for virtually every major industry, including banking, manufacturing, pharmaceutical, government, etc.

SAS is the market leader in providing a new generation of business intelligence software and services that create true enterprise intelligence. SAS solutions are used at more than 39,000 sites — including 90% of the Fortune 500 — to develop more profitable relationships with customers and suppliers; to enable better, more accurate and informed decisions; and to drive organizations forward. SAS is the only vendor that completely integrates leading data warehousing, analytics and traditional BI applications to create intelligence from massive amounts of data. For more than 25 years, SAS has been giving customers around the world The Power to Know®.

SAS software is developed and distributed by the SAS Institute of Cary, North Carolina. It is one of the top 10 independent software vendors in the world and the leader in decision support and data warehousing.

SAS Institute provides packaged business solutions for vertical industry and departmental applications through an integrated suite of software tools that transform the wide variety of data within organizations into useful information at more than 40,000 business, government and university sites in 115 countries.

SAS software, with its wide variety of tools and modules, can rapidly draw data from a variety of platforms and applications, drawing together unique data trends of information for decision making and application development.

Millions of records can be rapidly analyzed, allowing a constant inflow of data to be repeatedly organized. This allows decision makers the unique ability to evaluate trends, to make sense of vast amounts of data, allowing for accurate and timely decision making.[18]

D. COMPARISON OF GAUSSSOFT PROFIT ABM/KVA VS. SAS/ABM

This comparison is provided courtesy of GaussSoft, Inc. and shows the advantages of GaussSoft Profit Activity Based Management (ABM)/KVA software over SAS/ABM. It focuses on the important concepts and functionalities that support near real-time monitoring, and decision making in the MDA environment. This is not a feature by feature comparison.

Table 3. SAS vs. GaussSoft Summary

	SAS ABM	GAUSS	BENEFITS
Flexibility and Adaptability	Extended ABC	Multilevel ABC	-GaussSoft accommodates much better to the organizations' process and cost model. -SAS cannot represent many of the situations. Artificial solutions make SAS hard to implement and maintain.
Uses KVA	It does not include KVA	Includes KVA	-GaussSoft KVA capability allows making better decisions.
Details	Produces limited results per Object	Produces full P and L statements	-Full details allow understanding why things happened, shows where the problem is and provides information on how to solve it.
Tracing Capabilities	Includes tracing capabilities, but with limited detail	Includes full tracing capabilities, at account level and though time	-GaussSoft gives much more analytic power, in a easier and natural way, to implement and to maintain, and to analyze
Accumulate between periods	Impossibility to valuate processes or projects that take longer than the valuation period	Accounts for activities that produce results in other periods and calculates cost correctly	-With SAS, in processes that take more than the measuring period the errors can be big.

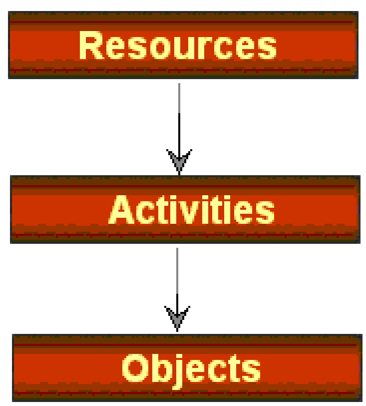
[18] Qualex Consulting Services Inc. and SAS Institute Inc. located at http://www.qlx.com/sas/index.html, (Accessed 20 March 2008).

Accounts of different nature	Does not allow to allocate accounts of different nature	Allows to separately allocate accounts of different nature; for example, assets, liabilities, revenues and costs	-GaussSoft Profit allows to calculate indicators like EVA, indebtedness, ROA, and others

1. Modeling Flexibility and Adaptability

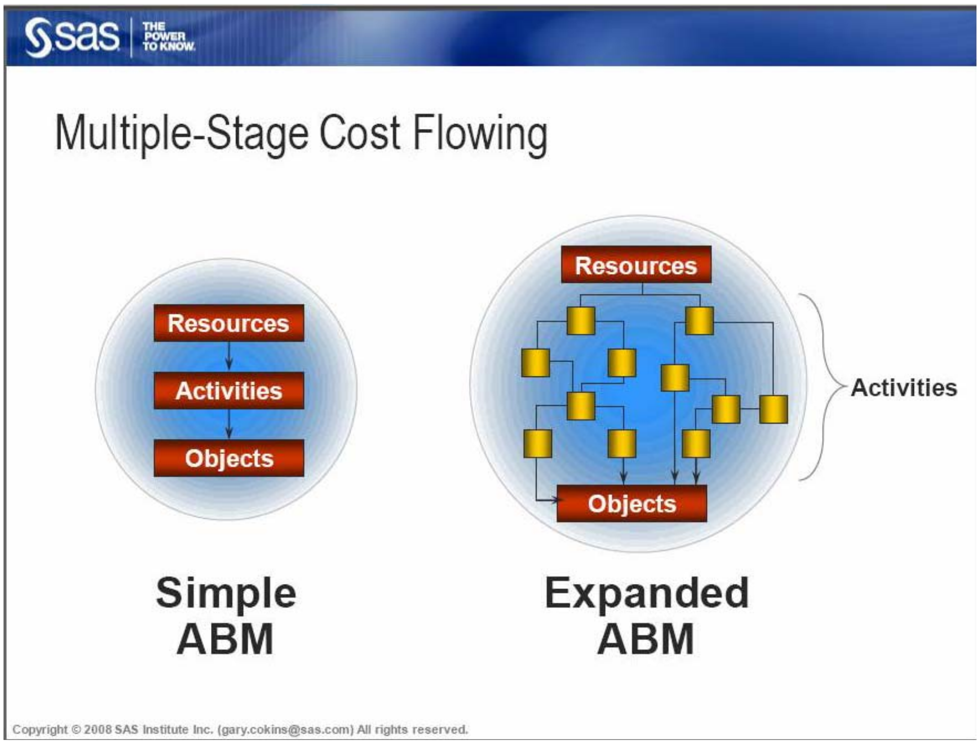
Activity Based Costing (ABC) methodology started very simple: Resources perform activities that are consumed by objects. For example: A Support Team (Resource) gives Technical Support (Activity) to customer X (Object). The cost of resources is allocated to activities according to some driver, and the cost of activities to resources according to some other driver. This proved to be better than just allocating from Resources to Objects. This is called in the following figure Simple ABC:

Figure 5. Simple ABC



Soon it became evident that companies do not work in such a simple way, and found out that a great number of activities can not be linked easily to objects, for example “planning,” “scheduling,” “design,” “training,” and “payroll management.” Then Extended ABC (also known as Expanded ABM) was introduced; it allows some activities or process to be linked to others in several layers until they can be assigned to the objects. The following figure shows what SAS considers great flexibility in costing modeling.

Figure 6. SAS Simple and Expanded ABM Models



This extended ABM solution, although better than Simple ABC, is not only unnatural but impractical. For this reason many ABC projects became really hard to implement and maintain, and eventually lost credibility in many sectors.

The fundamental conceptual error is that they disregard an obvious fact: Some resources can be objects themselves. For example: The activity "Job Training" is not performed to the customers or products, but to other people or teams in the company. They are objects as well as resources. These resources consume cost from many other activities and this is part of their cost that has to be allocated to the activities they perform to other objects.

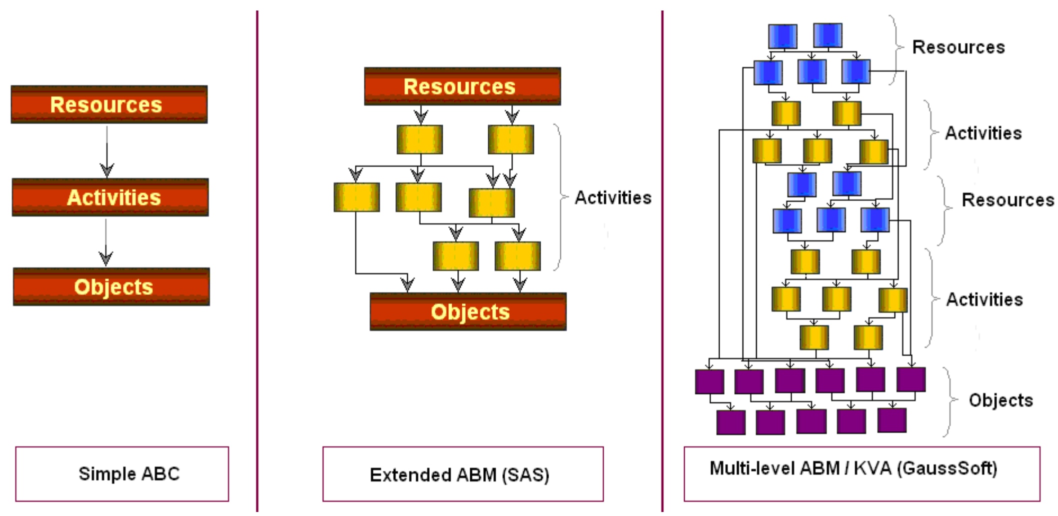
According to the company's needs, they can consider cases (or even the entire model) as real costing, where they do not need to analyze costing information through processes or activities, but by cost centers, areas, or directly from resources to objects (final or not).

The relations from resources, activities, areas, and cost objects (and any other element in your organization) are not balanced in a one-level-to-the-following-level schema; the relations between the components of an entity are as they need to be, not as a costing modeling concept says it is. SAS/ABM is limited to ABC/ABM methodologies; GaussSoft Profit ABM/KVA is not!

This is a real breakthrough in costing, and GaussSoft Inc. refers to it as Multi-level ABM/KVA; GaussSoft Profit ABM/KVA is the first software to implement it, and does it in a natural way.

Here you can see clearly the difference between the three approaches. Which one will help you reflect your organization as it really works?

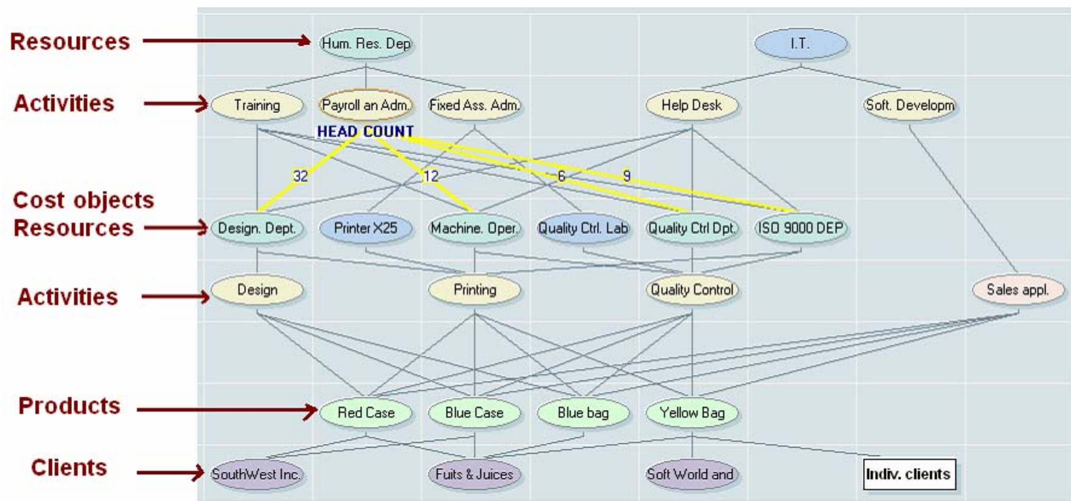
Figure 7. Comparison of SAS and GaussSoft ABC/ABM Models



GaussSoft Profit ABM/KVA is software that has no restriction in the way you model Resources, Activities and Objects. The model represents how the company is; you are not required to create artificial relations.

The following model shows a model that can be created with GaussSoft Profit AMB/KVA and not with other software products like SAS/ABM:

Figure 8. ABC/ABM GaussSoft Model



2. Real Valuation at the Sub-Corporate Level Using KVA

Calculating cost correctly for activities and processes is a great improvement and is really necessary for analysis and decision making. Nevertheless, some part of the equation is still missing.

Let's say that now because of ABM we are able to say for certain that the IT department costs \$10M and spends \$4M in software development, 2M in software maintenance and 4M in other things. We want to reduce the cost by 30%. The simple solution is to "cut off everything by 30"; usually it means people and related processes. This serves the purpose, but the problem is that we don't know how much value is being also reduced. If value reduced is 40% the organization is making a bad deal, it is loosing 10 points overall. If we knew which components are worth what value, we could cut cost without sacrificing value and hurting the organization, and even better, being able to select better alternatives.

KVA is a methodology that helps to do this. GaussSoft Profit ABM/KVA is the first (and only) costing software that includes KVA, and makes it possible to automate it

and relate it to cost, generate appropriate indicators and track the behavior in time. SAS/ABM does not implement KVA (is limited to ABC/ABM).

3. Result Details

Knowing that some Object (Product, Project, Customer, and Region) has negative profit or high cost is important. But being able to understand why and have more detail is necessary to understand the reasons and find solutions (the difference between knowing and guessing).

SAS/ABM produces summarized and limited results per each Object. On the other hand, GaussSoft Profit ABM/KVA produces full Profit and Loss Statements at the Object Level.

4. Tracing Capabilities

Tracing is the ability to track a particular cost from an object (final or not, including resources, areas and activities) to the source. Due to modeling restrictions, SAS/ABM has tracing capabilities that are difficult to implement (as unnatural), but very limited compared to those of GaussSoft Profit ABM/KVA.

5. Accumulation between Periods

One of the big problems of ABC/ABM tools is that they require a closed time period to evaluate the model. This means that everything is supposed to happen within that period.

For example: In period 1, you spent $100 in resources in activities and process to produce ten objects of type X, but only five objects were actually produced. The computer system doesn’t know that the effort was meant for ten not for five, and the cost per unit is calculated as $20 instead of $10 (the correct cost). In period 2, five more items are produced, but the effort looks like $0 this time. If you are costing, for example, an IT project, this problem is more critical.

In SAS/ABM there is no way to tell the system the difference between produced and consumed, and most important there is absolutely no way to "store" the effort of one period and consume it in the next (or other period).

If companies have projects or processes that are very costly and take longer than the length of the period, the deviation error is big, sometimes reaching 300% or more. Even errors of 20% can make you make the wrong decision and eventually discard the system.

6. Accounts of Different Nature

Sometimes in the model is necessary to include other things than cost; for example, value of an asset or liabilities. If you can't include these elements, your results will be very limited from a financial approach; cost is not the only thing that matters. It is important to note that because revenue/cost and assets/liabilities are different things that can not be summed up, they must be allocated separately.

In GaussSoft Profit ABM/KVA, numbers (accounts) can be allocated in the same way as cost or revenue is allocated, and kept separately to maintain the nature of the account for analysis purposes. The results of assets/liabilities allocation can be used in combination with cost and revenue information, to obtain relevant indicators, such as Economic Value Added (EVA), indebtedness and Return On Assets (ROA). In SAS/ABM you can include costs and revenue, but cannot include assets, liabilities or other type of accounts and manage them correctly.

E. CONCLUSION

GaussSoft is the BI solution of choice over SAS for this thesis, because it is relatively inexpensive, more flexible, and, unlike SAS, it calculates KVA. Calculating KVA of the MDA "As Is" workflow processes are at the crux of this thesis, and although such calculations can be accomplished by other means, GaussSoft KVA solution is the ideal tool. Displaying representations of processes in graphical and numerical forms, allows decision makers to quickly interpret process performance and identify what processes require changes. Decision makers can also project the effects of those process

changes and track the actual changes with continuous near real-time data collection, all of which are qualities of GaussSoft, which make it the preferred BI tool for this thesis.

V. OPEN ARCHITECTURE ENVIRONMENT AND TENETS

A. INTRODUCTION

Achieving efficiency in computing software and eliminating software upgrade inadequacies are important throughout the DoD. Therefore, it is very relevant to MDA that emerging technologies are used to support the MDA strategy, because time and costs to produce the technology are strategic resources that can be respectively managed and reduced via open architecture usage and business process auditing. This thesis explores these possibilities in a relevant fashion for the benefit of decision making pertaining to the MDA environment.

A previous study conducted at the Naval Postgraduate School by Capt. Joseph Uchytil, *"Assessing the Operational Value of Situational Awareness of AEGIS and Ship Self-Defense System (SSDS) Platforms through the Application of the Knowledge Value Added (KVA) Methodology,"* demonstrated that KVA could be used to estimate the performance of an OA implementation in terms of a Return on Investment (ROI).[19] The thesis also concluded that collaboration, along with the tools that facilitate collaboration, is critical to the success of any of the OA approaches.

While Capt. Uchytil's research focused on benefits derived from the AEGIS and SSDS perspectives, the purpose of this thesis is to implement KVA software and assess the KVA and ROI of the MDA "As Is" process workflow using OA.

B. NAVY OPEN ARCHITECTURE (OA)

Navy Open Architecture (OA) is a systems design approach supported by governmental testing platforms, such as the Open Architecture Computing Environment (OACE) (the standards based computing infrastructure used by Surface Command and

[19] Uchytil, J., "Assessing the Operational Value of Situational Awareness for AEGIS and Ship Self-Defense System (SSDS) Platforms through the Application of the Knowledge Value-Added (KVA) Methodology," Master of Science in Information Technology Management, Naval Postgraduate School, 2006 (Accessed 29 February 2008).

Control (C2) Domain software applications), that seeks to implement open specifications (standards and compliance criteria and compliance assessment for any U.S. Navy OA technology) for interfaces, services and supporting formats. It enables software components to work across a range of systems and interoperate with other software components on local and remote systems.

The Navy OA promotes interaction between designers, suppliers and end users that facilitates portability. Through OA, common standards and products are employed in the areas of frameworks, middleware, resource management, and operating systems, utilizing established and evolving industry standards.

OACE is a compatible set of largely standards-based commercial-off-the-shelf (COTS) computing infrastructure components (hardware and software) that provide the computational framework upon which tactical and support applications are built, under the guidelines of OA. The scope of OACE includes technical architecture, standards and products.[20]

Department of Defense systems, according to a report release in 2006 by the Government Accountability Office, continue to lag behind in interoperability, even though the Program Executive Office, Integrated Warfare Systems (PEO IWS) was established in 2002 and was in charge of executing OA.[21]

OA creates greater flexibility by introducing additional technologies and capabilities to the fleet which closed systems of the past have failed to introduce after procurement. This is primarily due to closed systems not being as amenable to rapid upgrades as open systems. Current and future systems need to be fluid and dynamic to respond to and anticipate the anomalies encountered on ships.

Additionally, it is hard to maintain proprietary systems because of their interdependencies in code and software. Due to lifecycle time and cost constraints, OA,

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[20] U.S. Navy Open Architecture (OA) Operating Systems, http://www.lynuxworks.com/solutions/milaero/navy-open-architecture.php (Accessed 29 February 2008).

[21] Government Accountability Office. “Defense Acquisitions: DoD Management Approach and Processes Not Well-Suited to Support Development of Information Grid,” Government Accountability Office, 2006 (Accessed 29 February 2008).

which offers faster business and system models to the acquirer and developer and independent coding, should be adequately used in order to promote the future view of a Navy.

OA is realized through rapid change and fluid upgrades and solutions. According to the Deputy Chief of Naval Operations, the requirements for OA implementation are as follows: modular design and design disclosure, reusable application software, interoperable joint warfighting applications and secure information exchange, life cycle affordability, encouraging competition and collaboration, scalability and portability.[22]

1. Modular Design and Design Disclosure

Modularity is the concept of decomposing a system into transparent subcomponents.[23] These subcomponents are operable without relying on another aspect of the system; hence, they can rapidly change and allow for interactions with numerous systems. The underlying goal of decomposition, in the case of modularity, is to allow for the independent upgrade of each of the smallest subcomponents while leaving the complete system operable. With modular design and design disclosure, multiple competitors can participate and innovation flourishes as each subcomponent is independently tried and tested.

2. Reusable Application Software

Reuse allows a system to use the same components and code that have been used across other platforms.[24] In the case of application software, a database of segments of code that worked for the tracking device of one platform can be shared when creating other tracking devices. This would be a database that would be continually updated with

[22] Department of Defense, NAVSEA, PEO IWS, "Open Architecture Computing Environment Technologies and Standards," Version 1.0. Washington, D.C.: Department of Defense, NAVSEA, PEO IWS, 2004 (Accessed 15 March 2007).

[23] Coronado Mondragon, C. E., Coronado Mondragon, A. E., and Miller R., "Modularity, Open Architecture and Innovation: An Automotive Perspective." *International Journal of Automotive Technology and Management* 6, no. 3 (2006): 346-363 (Accessed 10 February 2008), p. 247.

[24] Department of Defense, NAVSEA, PEO IWS, "Open Architecture Computing Environment Technologies and Standards," Version 1.0. Washington, D.C.: Department of Defense, NAVSEA, PEO IWS, 2004 (Accessed 15 March 2007).

components and segments of code that could have potential use in other areas. These components can be used interchangeably with other components without affecting the system in its entirety. This idea is revolutionary for coding and software upgrade in much the same way that "interchangeable parts" revolutionized the assembly lines of the 1920s, with increased output and increased revenue. Disclosure of the design of application software would also be necessary for evolutionary improvement in future upgrades.[25] Theoretically, organizations can save time, effort, and money via reuse of pre-built software code, which has been certified and approved, as multi-purpose solutions. The invested costs would be derived from the development of the software code, which could be used over an over for various uses without having to be developed for each need or purpose, therefore allowing for increased output of processed data. Also, because the U.S. Navy is a non-profit organization, instead of increased revenue it would have an increased savings.

3. Interoperable Joint Warfighting Applications and Secure Information Exchange

This particular tenet ensures that across a wide variety of systems, the same information and applications can be shared. It involves commonality of services, warfighting applications, and information assurance, and requires these commonalities to be essential for the basic design elements of any new system.[26]

4. Life Cycle Affordability

This tenet includes all phases of the life cycle, from design and requirements gathering to delivery and testing. Since the primary concern of this thesis is implementing KVA software within the MDA environment, consideration of the MDA Spiral-1's life cycle costs may provide results which could directly benefit the implementation of OA, with respect to life cycle affordability.

[25] Department of Defense, NAVSEA, PEO IWS, "Open Architecture Computing Environment Technologies and Standards," Version 1.0. Washington, D.C.: Department of Defense, NAVSEA, PEO IWS, 2004 (Accessed 15 March 2007).

[26] Ibid.

5. Encouraging Competition and Collaboration

OA naturally encourages competition and collaboration because unlike closed systems, many different systems can be integrated to complete upgrades or create a new system. That is not to say that proprietary systems do not contain many different parts that require different companies to collaborate, but they are less likely to constantly create an environment of competition and innovation, because some of the contracts are sole-source. Sole source contracts are those which restrict full open competition, and are non-competitive procurement processes, in which solicitation is only with one source.[27]

6. Scalability

Scalability encompasses the same functionality but on a larger or smaller scale into a system, without procuring a whole new system to do the same job. An example of scalability is the method of increasing bandwidth during the holiday season to allow for faster transactions during a season of heightened traffic.

7. Portability

Portability is the ability of the software or hardware and the users to easily integrate into different platforms. It requires source code to make transitions between hardware and software and requires the switch to be rapidly and smoothly accomplished.

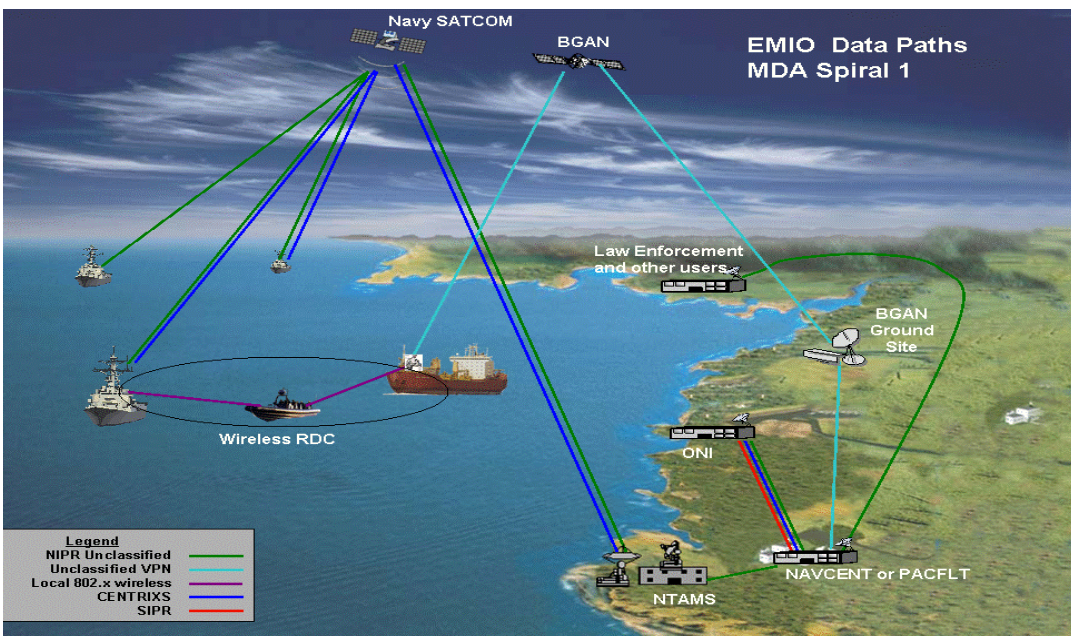
C. MDA SPIRAL-1

MDA Spiral-1 is an open-architecture-based effort, aimed to provide solutions for semi-automated, near real-time, data capture and publishing of boarding data. It is called "Spiral-1," because it is the first increment where MDA implementation will evolve through a spiral development process. The MDA Spiral-1 concept involves making boarding data available to both distant and local Coalition Intel Fusion Center

[27] Department of Defense Directive 5000.1, "The Defense Acquisition System.," May 2003, https://akss.dau.mil/dag/DoD5000.asp?view=document&rf=GuideBook\IG_c2.3.16.1.asp (Accessed 29 February 2008).

(CIFC) analysts, as well as ONI and other agency intelligence analysts, and making boarding data available locally to all units involved in performing Expanded Maritime Interception Operation (EMIO). Implementing the concept of MDA Spiral-1 provides answers to issues regarding functionality over the limited bandwidth and high latency networks available to most US and Coalition ships. Collaborative information sharing capabilities, as illustrated in the EMIO Mission Communications figure below, provide added value in terms of situational awareness to all parties, because of the high-level movement of boarding data and the different nodes involved. When conducting visit, board, search, and seizure (VBSS), the boarding team (BT) on the boarded vessel sends captured data over an encrypted, but unclassified commercial satellite path to a shore-based server.[28]

Figure 9. EMIO Mission Communications[29]



[28] Farrar, A., "EMIO MDA Spiral 1 Overview and Scoping," White Paper on MIO/EMIO Requirements Overview and Vision as Applied to SECNAV MDA Prototype Effort (Draft), US Navy PEO C4I, November 2007.p.6.

[29] Ibid.

Because of the components of this OA, the data is kept both at the unclassified level as well as moved to high classification domains, to make the data available to the widest set of users. OA tenets, namely modularity, interoperability, scalability, and reuse, provide a means to efficiently share data within each domain to all interdiction-capable ships in the region, other Network Operation Centers, and back into the ONI SeaPort database at the Nation Maritime Intelligence Center via CaS Seaport Data Replication technology, which provides fielding acceleration and expansion of the fleet/ONI CaS/SEAPORT initiative, as shown in Figure 10.[30]

Managing data based on classification levels, is a major focus of this approach. The solution is to maintain and label the data at the classification level it was captured, allowing it to be made available at higher security levels, while providing for increased data sharing. In order to allow other organizations from the DoD, Department of Homeland Security (DHS), and law enforcement to provide additional insights to the information captured by the BT, this solution allows the storing of data at the unclassified, but protected level.

[30] Farrar, A., "EMIO MDA Spiral 1 Overview and Scoping," White Paper on MIO/EMIO Requirements Overview and Vision as Applied to SECNAV MDA Prototype Effort (Draft), US Navy PEO C4I, November 2007. p 7.

Table 4. CaS Seaport Data Replication Topology[31]

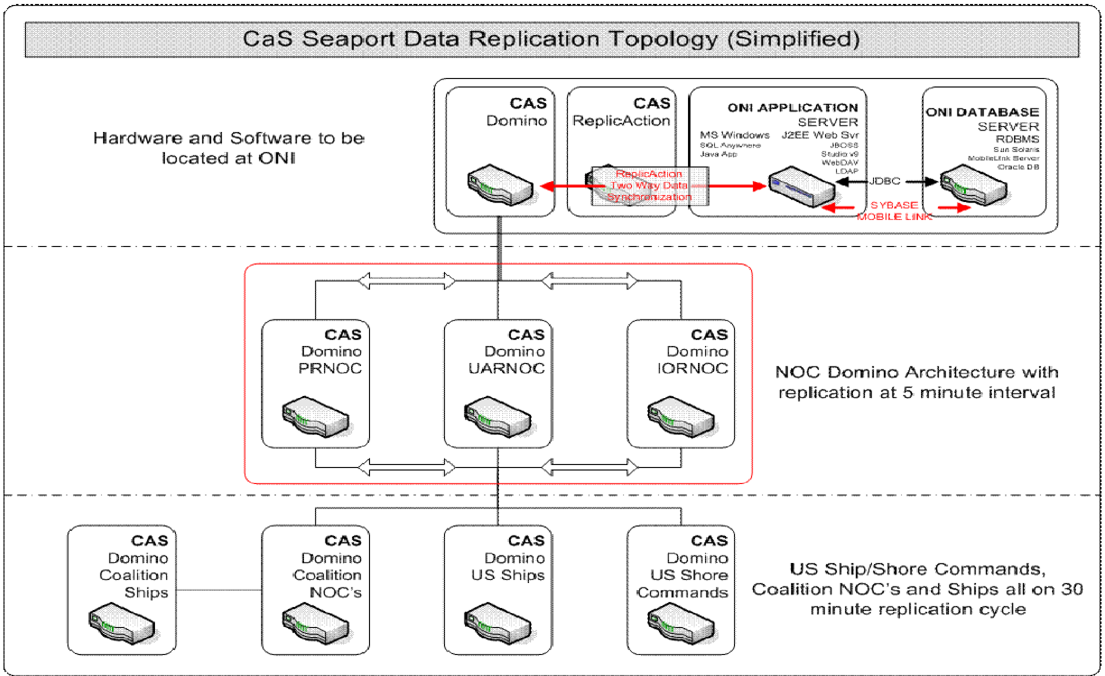


Figure 10 illustrates how data from each ship boarding will be replicated to all related US and coalition ships, using current Navy afloat data distribution mechanisms, and then sent back to ONI for additional analysis and validation.[32]

Equipped with enhanced configurable boarding/visit gear, BTs will capture and transmit images and text data utilizing either their own organic Broadband Global Area Network (BGAN) Satellite Communication (SATCOM) link capability or, where available, a local wireless network connection back to their parent ship, and then over the ship's own SATCOM capability. These connections will allow for the boarding data to be sent in near real-time back to the CIFC and other intelligence exploitation organizations. BT kits will also be configurable to run with or without the ability to capture biometric data. Figure 11 illustrates the boarding team kit and data path for boarding information.[33]

[31] Farrar, A., "EMIO MDA Spiral 1 Overview and Scoping," White Paper on MIO/EMIO Requirements Overview and Vision as Applied to SECNAV MDA Prototype Effort (Draft), US Navy PEO C4I, November 2007. p 7.

[32] Ibid.

[33] Ibid.

Figure 10. Boarding Team Kit and Boarding Information Data Path[34]

The Rapid Development Capability (RDC) DoD acquisition program is installing wireless capabilities on U.S. ships, allowing for connectivity between the parent ship and any local rigid-hulled inflatable boats (RHIBs), and if this link is available it can be used.[35]

Figure 12 shows the evolution of the biometrics devices in the BT kits. The BT kits will include the capability to plug in whichever biometric kit is current, and prioritize the biometric traffic to allow it to be checked while the team is still on board the vessel.[36]

[34] Farrar, A., “EMIO MDA Spiral 1 Overview and Scoping,” White Paper on MIO/EMIO Requirements Overview and Vision as Applied to SECNAV MDA Prototype Effort (Draft), US Navy PEO C4I, November 2007, p 7.

[35] Farrar, A., “EMIO MDA Spiral 1 Overview and Scoping,” White Paper on MIO/EMIO Requirements Overview and Vision as Applied to SECNAV MDA Prototype Effort (Draft), US Navy PEO C4I, November 2007, p 7.

[36] Ibid, p 8.

Figure 11. Boarding Team Kit - Biometric Devices[37]

D. CONCLUSION

In summary, the ability to capitalize on the concept and application of OA within this thesis is not only relevant, but is proven significantly useful. Capitalizing on this technology requires ensuring that the selections of COTS meet the specifications that are in alignment with the seven tenets of OA. This chapter specifically describes OA and illustrates some of the technology used to support the OA concept, because of its direct contribution to MDA as a means to continuously collect and share information. This technology is resident within each process of the MDA "As Is" workflow model. As this thesis explores measuring the contribution of human and IT knowledge assets, the OA technology within each process are examples of the IT knowledge assets being measured.

[37] Farrar, A., "EMIO MDA Spiral 1 Overview and Scoping," White Paper on MIO/EMIO Requirements Overview and Vision as Applied to SECNAV MDA Prototype Effort (Draft), US Navy PEO C4I, November 2007, p 7.

VI. MDA "AS IS" WORKFLOW MODEL

A. INTRODUCTION

From the MDA "As Is" workflow model (Figure 14), the Spiral-1 effort focuses on establishing core net-centric capabilities at multiple levels of security, while feeding and fusing many data streams into a coherent common operational picture, and provides improved analytical and collaboration tools. This workflow only looks at making decisions about a vessel from its first detection to its potential boarding. Each capability listed in Table 4 is performed by and matched with its installation node and concomitant technology.[38]

Based on US Air Force Retired Col. John Boyd's OODA (Observe-Orient-Decide-Act) Loop, the framework for the MDA "As Is" workflow model's phases are organized in a fashion which supports the premise that decision making is the result of rational behavior and problems are viewed as a cycle of Observation, Orientation (situational awareness), Decision, and Action.[39]

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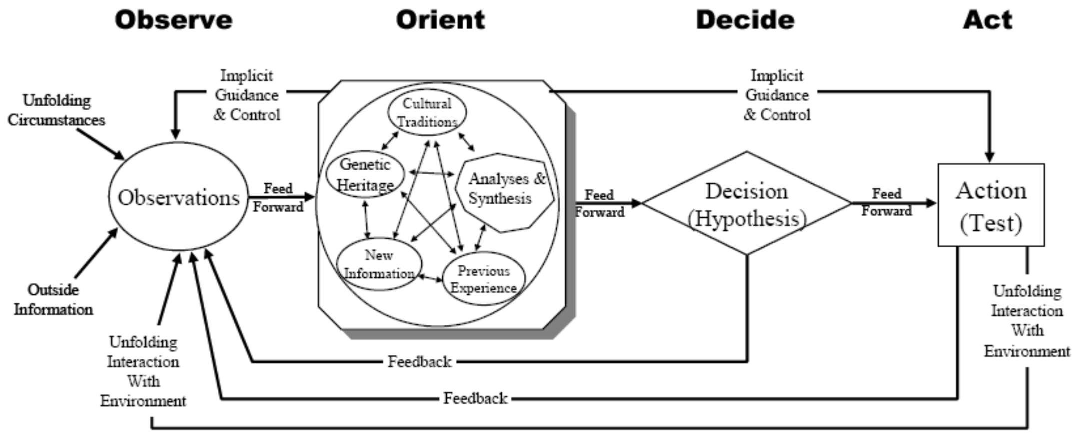
[38] Barton, C., *Maritime Domain Awareness Prototype FY08 SPIRAL 1 DRAFT Assessment Plan Version 1.0a*., Naval Postgraduate School/SPAWAR, 14 December 2007.p.7.

[39] Clark, D., "OODA: Observe, Orient, Decide, & Act," http://www.nwlink.com/~donclark/leadership/ooda.html, 29 October 2004. (Accessed 29 February 2008).

Figure 12. Boyd's OODA Loop[40]



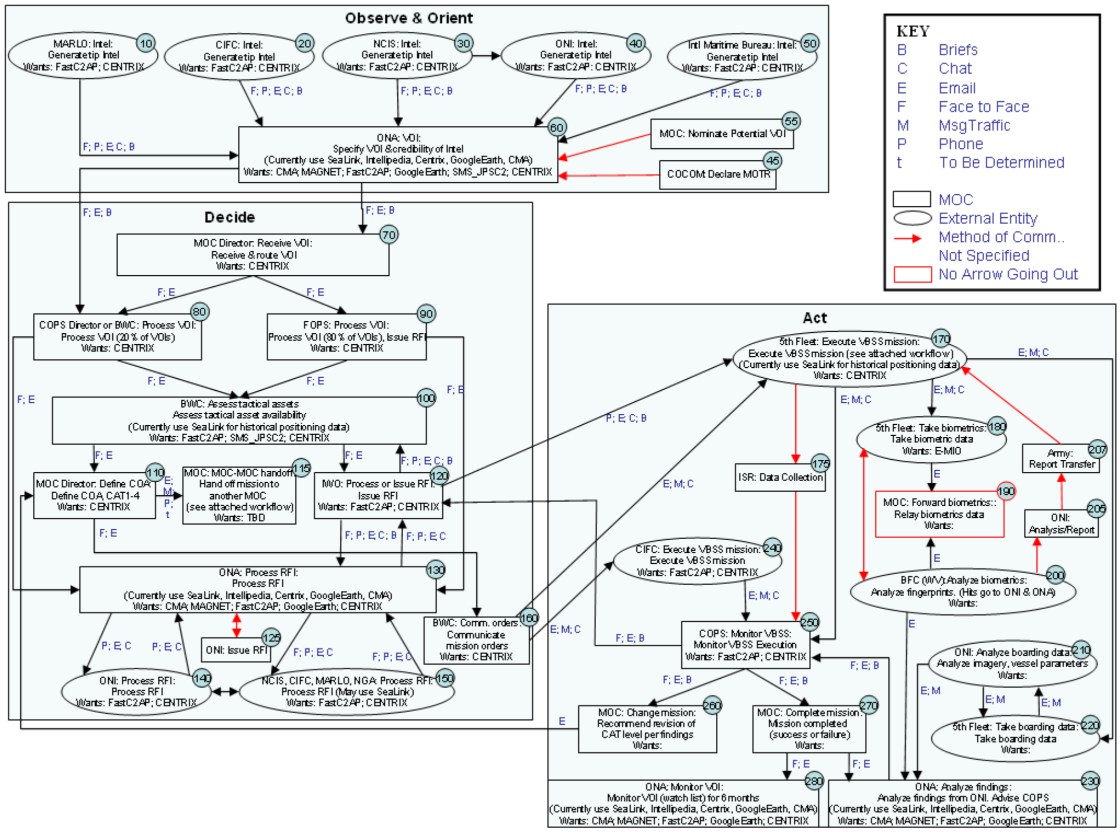
Four Phases of John Boyd's OODA Loop

- **"Observation** - Scan the environment and gather information from it.
- **Orientation** - Use the information to form a mental image of the circumstances. That is, synthesize the data into information. As more information is received, you "deconstruct" old images and then "create" new images. Orientation emphasizes the context in which events occur, so that decisions and actions may be facilitated. As a result, orientation helps turn information into knowledge. Knowledge, not information, is the real predictor of making good decisions.
- **Decision** - Consider options and select a subsequent course of action.
- **Action** - Carry out the conceived decision. Once the result of the action is observed, you start over. Note that in combat (or competing against the competition), you want to cycle through the four steps faster and better than the enemy, hence, it is a loop."[41]

40 Lawson, E., Ferris, T., Cropley, D. and Cook, S.," Development of a Foundation for Military Network Science," Systems Engineering and Evaluation Centre (SEEC), University of South Australia, 15 June 06, Located at http://www.dsto.defence.gov.au/attachments/Final%20Report%20Network%20Science%2019%20June.pdf, (Accessed 29 February 2008).

41 Clark, Donald. OODA: Observe, Orient, Decide, & Act. http://www.nwlink.com/~donclark/leadership/ooda.html 29 Oct 2004. (Accessed 29 February 2008).

Figure 13. MDA “As Is” Work Flow Model



The following describes the MDA “As Is” workflow model, its OODA Loop phases, internal processes, and connections. Refer to Table 4 for a listing of technical capabilities and descriptions of the technologies.

B. OBSERVE & ORIENT

In Figure 15, below, we see the commencement of the OODA Loop at the Observe & Orient phase comprised of eight processes.

Process 10, MARLO is a Maritime Liaison Office located in Bahrain. It is unclassified and run by civilians. They gather ship information, look for suspicious activity, and send what they know to Process 60, for operational net assessment (ONA) regarding the vessel of interest (VOI).

Process 20, CIFC is a Coalition Intelligence Fusion Center run by ally countries very similar to a streamlined version of a Maritime Operations Center (MOC). They gather ship information, look for suspicious activity, and send what they know to Process 60, for operational net assessment (ONA) regarding the vessel of interest (VOI).

Process 30, NCIS is a Navy Criminal Investigative Service run by local people who live in the area who provide information about suspicious ships. This is referred to as “human intelligence” and they gather ship information, look for suspicious activity, and send what they know to Process 60, for operational net assessment (ONA) regarding the vessel of interest (VOI).

Process 40, ONI is the Office of Naval Intelligence which generates most of the intelligence and analysis of suspicious ships. They complete the analysis before sending to Process 60. (Also, ONI gets tipper information from Process 30 to analyze.)

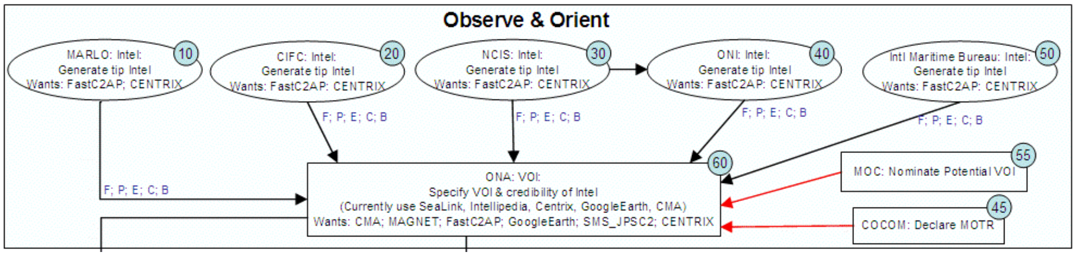
Process 50, International Maritime Bureau (IMB) which looks out for suspicious ships, is a specialized division of the International Chamber Of Commerce (ICC). The IMB acts as a focal point in the fight against all types of maritime crime and malpractice, and it also does the same as Process 10.

Process 55 nominates potential VOI and also Generates Intel. It also does the same process as Process 10.

Process 45, Combatant Command (COCOM), is comprised of major fleet commanders and declares the National Maritime Operation Threat Response (MOTR). It gives input as to whether vessel is a VOI.

Process 60, ONI, takes all given information from all external entities and processes, and determines if a suspicious ship is a VOI. Also, it sends information to Process 70 and 80 via either Face-to-Face, Email, and or Briefs to the “Decide” phase of the OODA Loop.

Figure 14. MDA “As Is” Work Flow Model - Observe & Orient



C. DECIDE

In Figure 16, below, we see the “Decide” phase comprised of fourteen processes.

Process 70, Director gets report of VOI indication and decides if it is a current issue (needs to be dealt with within 4 hours--emergency) or future issue (anything that can be dealt with within more than 4 hours). Next, it sends information to Process 80 and 90 via either Face-to-Face and/or Email.

Process 80, Current Operations (COPS) Cell in MOC, or Battle Watch Captain (BWC), processes 20% of VOIs. It notifies different monitoring ships and watches to determine “if” the suspicious ship is a VOI and “why” it is a VOI. Next, it sends information to Process 100 and 130 via either Face-to-Face and/or Email.

Process 90, Future Operations (FOPS), does the same as Process 80, but it deals only with non-emergency issues and it processes 80% of VOIs. It issues requests for information (RFI) and wants CENTRIX technology. Next, it sends information to Process 100 and 130 via either Face-to-Face and or Email.

Process 100, BWC, assess tactical assets and their availability, then decides what to do, based on where its assets (ships, aircrafts, etc.) are located, where it wants to allocate them, and what assignment it desires to give them.

Process 110, MOC Director, decides what actions to take regarding what BWC tells him and based on the overall picture. It defines the Course of Action (COA) and the utilization of Crisis Action Teams (CAT). It also receives information from the “ACT”

phase of the OODA Loop sent from Process 260 via Email. It sends information to Process 115 via Email, Message Traffic, Phone, and To-Be-Determined and to Process 160 via Face-to-Face and Email.

Process 115, MOC-MOC handoff, hands-off the mission to another MOC. If the VOI is moving too far away, they need to hand it off to another MOC to watch.

Process 120, Intelligence Watch Officer (IWO), moves information forward or, if it has more questions, it does an RFI. If IWO personnel have intelligence information, they utilize CENTRIX chat technology to communicate with the IWO. If the IWO's personnel do not have intelligence info, the IWO is required to get an RFI from ONI, which will take longer. It sends information to Processes 100 and 130 via Face-to-Face, Phone, Email, Chat, and Briefs. It also receives information from Process 250 of the "ACT" phase and sends information to Process 170 via Phone, Email, Chat, and Briefs.

Process 125, ONI, does an RFI with Process 130, the ONA, but is not integral to the "Decide" phase.

Process 130, ONA, when RFI is received from ONI (as a result of IWO asking for information), ONA assesses the information received and then determines what to do with the VOI (i.e. board, leave it, etc.). Then it sends information to Processes 120, 125, 140, and 150. All communications from Process 130 are via Face-to-Face (except with Process 140), Phone, Email, and Chat. It currently uses SeaLink, Intellipedia, CENTRIX, Google Earth, and CMA technologies, but wants MAGNET and FastC2AP technologies.

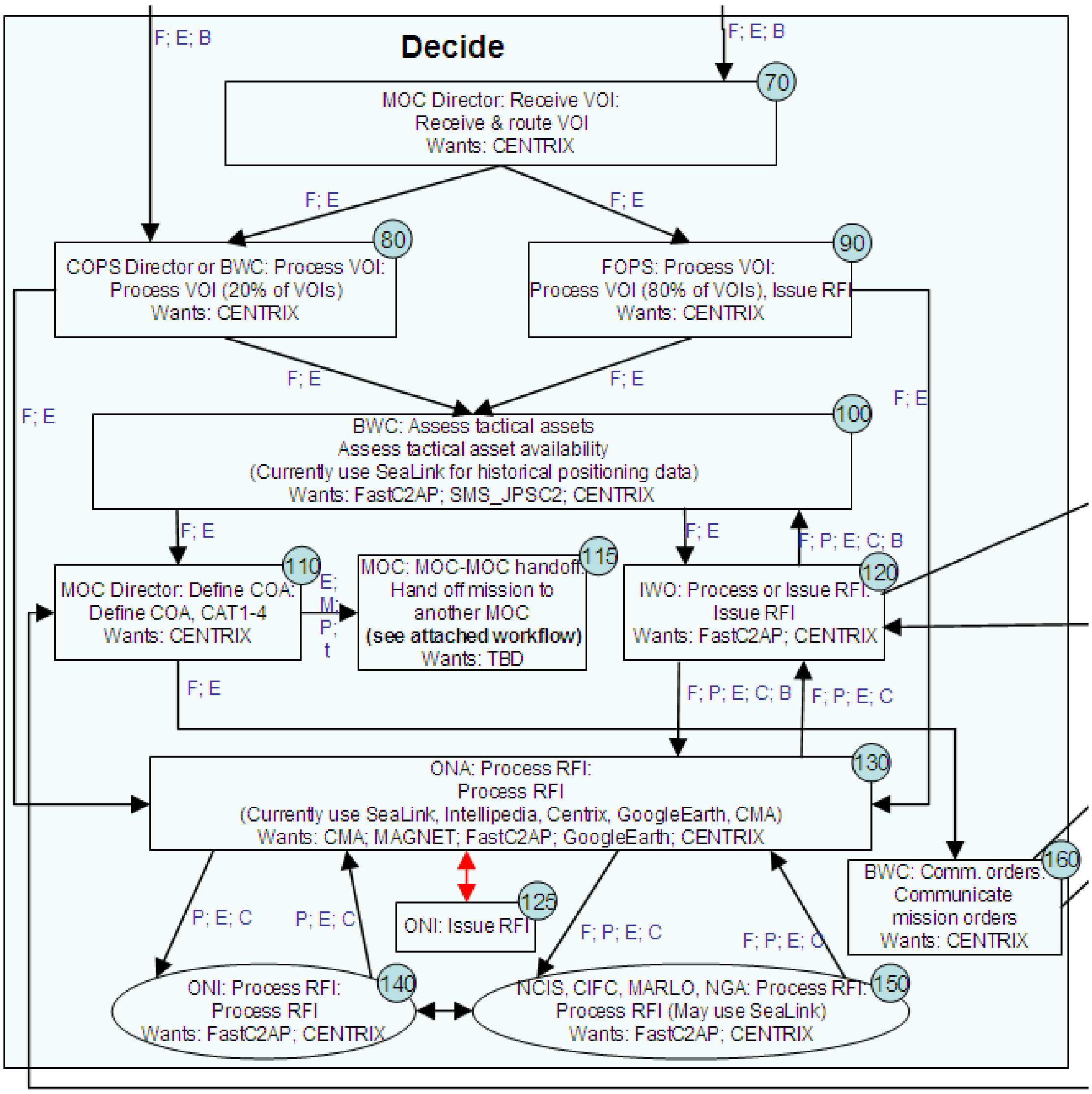
Process 140, ONI, processes any additional RFIs from ONA, and exchanges information with Process 150. It then sends information back to Process 130 via Face-to-Face, Phone, Email, and Chat.

Process 150 consists of other organizations that are a secondary source for RFI and they process criminal investigation information. They then send information back to Process 130 via Face-to-Face, Phone, Email, and Chat.

Process 160, BWC, after MOC Director (Process 110) decides what to do with all the information, it then communicates orders of MOC Director to 5th Fleet ("Act" phase

Process 170) or to CIFC ("Act" phase Process 240) if it is a non-American issue, both via Phone, Email, Chat, and Brief.

Figure 15. MDA "As Is" Work Flow Model - Decide



D. ACT

Process 170, 5th fleet, executes the VBSS mission orders to board. (Refer to Figure 17.) It receives information from Process 207, Army, for report transfer via Phone, Email, Chat, and Phone. It receives information from the "Decide" phase Processes 120

and 160 via Email, Message Traffic, and Chat. It sends information to Process 175, ISR, for data collection, to Process 250, COPS, for VBSS monitoring, to Process 180, 5^{th} Fleet, for transferring biometric data and to Process 220, 5^{th} Fleet, for transferring boarding data via Email, Message Traffic, and Chat.

Process 180, 5^{th} Fleet, boards and takes biometrics, namely fingerprint, face recognition, names, pictures of documents, or manifests (captain has a manifest, showing who is on the ship) sent from Process 170 via Email, Message Traffic, and Chat. It sends information to Process 190 to relay biometrics data via Email. It sends to and receives information from Process 200, Biometric Fusion Center (BFC) West Virginia (WV).

Process 190, Forward Biometric Relay, sends biometric information on to WV. It also receives information from 5^{th} Fleet (Process 180) and the BFC WV (Process 200).

Process 200, BFC WV analyzes biometrics, but usually only fingerprints because of technology limitations. It sends and received information from 5^{th} Fleet, sends information to Process 190 for relaying biometric data, sends information to Process 205 (ONI) for analysis and reporting, and to Process 230 (ONA) to analyze findings. Information is sent via Email.

Process 205, ONI, analyzes report from BFC WV (Process 200) and sends information to Army (Process 207) for report transfer.

Process 207, ARMY, transfers the data to 5^{th} Fleet (Process 170) for use in execution of VBSS mission.

Process 210, ONI, analyzes boarding data such as imagery and vessel parameters. It sends information to 5^{th} Fleet (Process 230) for analysis findings via Email and Message Traffic. It sends and receives information from 5^{th} Fleet (Process 220) via Email and Message Traffic in order to share boarding data. ONI has more analysts than 5^{th} fleet.

Process 220, 5^{th} Fleet, gets a copy of the WV report and biometric data for archival purposes from Process 170 via Email, Message Traffic, and Chat. It also sends and receives boarding data from ONI (Process 210) via Email and Message Traffic.

Process 230, ONA, analyzes findings of ONI (Process 210) received via Email and Message Traffic, as well as biometric analysis received from BFC WV (Process 200) via Email. It also receives completed mission status from Process 270 via Face-to-Face and Email.

Process 175, Intelligence Surveillance Reconnaissance (ISR), collects any info about the ship before boarding takes place (i.e. electronic signature of the ship's radar, pictures of the ship). It receives information from 5th Fleet (Process 170) and sends information to COPS (Process 250) which monitors VBSS execution.

Process 250, COPS, monitors the boarding of CIFC (Process 240) or 5th Fleet (Process 170) both via Email, Message Traffic, and chat. It also monitors boarding by listening to the radio and hearing how the boarding officers are doing. It looks out for safety of the team. In addition, it receives information from ISR (Process 175) and from ONA (Process 230) via Face-to-Face, Email, and Briefs. It sends information to Process 260 when the mission changes and to Process 270 when there is a mission completion both via Face-to-Face, Email, and Briefs. It also sends information to the IWO (Process 120 in the Decide phase of the OODA Loop) via Face-to-Face, Email, and Briefs for the processing or issuing of RFI.

Process 240, CIFC, if it is a non-US ship, will execute the boarding mission. It receives information from Process 160 (BWC) which communicates mission orders via Email, Message Traffic, and Chat. It sends information regarding the execution of VBSS mission to COPS (Process 250) for monitoring.

Process 260, changes mission from a humanitarian issue to a criminal issue or vice versa, and relays information back to MOC Director (Process 110) via Email. It receives information from COPS (Process 250) via Face-to-Face, Email, and Briefs.

Process 270, provides mission complete information to ONA (Process 280 and 230) via Face-to-Face and Email.

Process 280, ONA, monitors the VOI and puts it on watch lists for six months. It receives mission complete information from Process 270.

Figure 16. MDA "As Is" Work Flow Model - Act

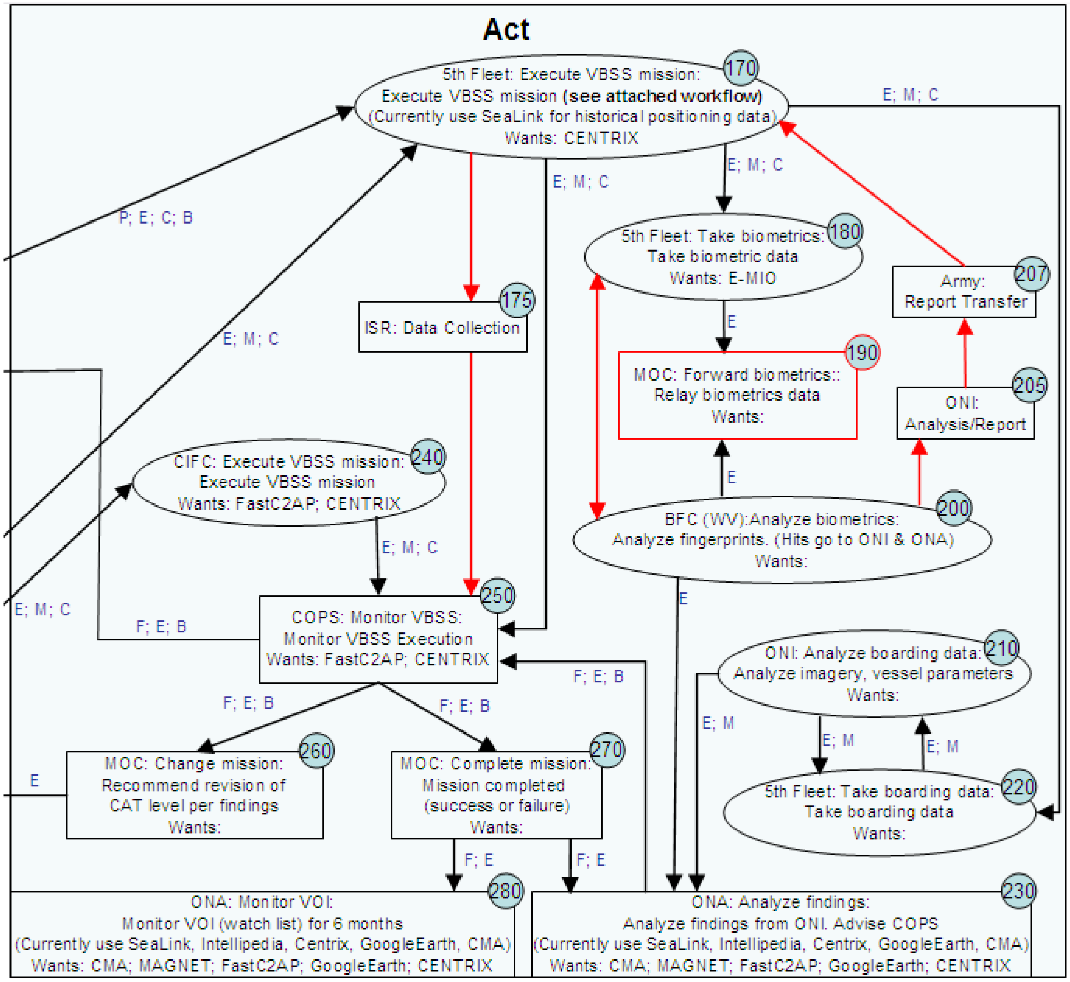


Table 5. Technical Capabilities: Description of Technology "Features"[42]

Capability	Node (Installed)	Technology	Improvement
1a. Enhanced Vessel Tracking	PACFLT and NAVCENT, in addition to existing JCTD nodes NMIC and MIFCPAC* * JCTD will also implement nodes at MIFCLANT and TMFC (Theater Maritime Fusion Center @ C6F)	CMA JCTD (via SIPRNET, + between Singapore and CENTRIXS-"CMFP-Bilat" via FIPS-192 VPN "tunnel within a tunnel")	Increased # of vessels, Reduced latency, Improved tracking AORs, Multi-INT fusion (level 1)
1b. Anomaly Detection (Vessels)	1. PACFLT, NAVCENT 2. USCG HQ	1. TAANDEM (Loosley coupled with CMA via SIPRNET) 2. MAGNET (USCG) (Included as part of Spiral 1 January 08 SIMEX)	Increased # of analytic models, Increased archived data for analysis, Access to commercial vessel data, Rule based automated anomaly detection
2a. Threat Detection (Vessels)	PACFLT, NAVCENT, NMIC	FASTC2AP (via SIPRNET)	Increased relationships analyzed, Reduced latency
2b. Threat Detection (People)	NMIC (already fielded by ONI)	TripWire (ONI Capability via SIPRNET)	Increased relationships analyzed, Reduced latency
3. E-MIO (People)	1. Force/Unit Level (Ship TBD, possibly coalition) 2. PRNOC (Linked to NMIC) 3. NMIC	1a. E-MIO Wireless & Biometrics RDCs (via ship-to-ship 802.11 wireless) 1b. Portable SATCOM (SEACAT Demo) 2a. SEAPORT/CAS SW (via SIPRNET, CENTRIXS-CNFC) 2b. PRNOC HW (New CENTRIXS-CMFP install) 3. ONI upgrade (CENTRIXS-CMFP engineering support)	Wireless comms from boarding party, reducing latency for data exfiltration Improved boarding team safety Automated ingest of boarding party data into authoritative databases
4a. Non-classified Collaboration / Dissemination	Google Service Center	Google Apps+Chat (via nonclassified Internet)	Improved speed of decision making. Increased data sharing between U.S. Navy, U.S. Agencies, and non-traditional partners
4b. Geospatial Collaboration	PACFLT, NAVCENT	Google Earth Fusion Server (via SIPRNET, CENTRIXS-CMFP, CENTRIXS-CNFC, and nonclassified Internet)	Improved shared situational awareness. Common geospatial viewers, and source data
5. Port & Coastal Surveillance	SCC-J San Diego (Available to others including MIFCPAC, NORTHCOM, JIATF-W, JIATF-S)	SMS/JPSC2 (via VPN tunnel over NIPRNET to a joint USN-USCG TACLAN)	Integrated, Multi-INT unclassified tactical picture data
6. Data Sharing with Law Enforcement	LINX	LINX web portal Proof-of-Concept (Discussions planned with NCIS)	Access to regional law enforcement database
7. Data Sharing with Coalition Allies	Australian Border Protection Command	AIS infrastructure (Discussions planned with DSTO)	Access to coalition AIS data

[42] Barton, C., *Maritime Domain Awareness Prototype FY08 SPIRAL 1 DRAFT Assessment Plan Version 1.0a*., Naval Postgraduate School/SPAWAR, 14 December 2007.p.7.

E. MDA “AS IS”WORKFLOW MODEL ANALYSIS

An analysis of each process in the MDA “As Is” workflow model is provided below in the Tables 5, 6, and 7 and Figures 18, and 19. The information provided for each analysis was produced through surveying subject matter experts and researching military and civilian pay for fiscal year 2008. “Actual Average Training Period” and “Average Time to Complete” are notional values and were not completely captured via survey. Each category for the KVA analysis is defined below.

1. Title of Head Process Executer

The “Title of Head Process Executer” category represents the job title of the person executing or overseeing the execution of the specific process or sub process. The process executors pay grade is indicated next to their job title. For purposes of this thesis, pay grades that erred on the high side were used to be conservative. If several executors with different pay grades were executing the same process then the highest pay grade was used as a baseline for that process executor. This produces the most conservative KVA results. Some other basic assumptions for this category were:

- Expenses consist of Personnel Costs.
- Base pay was a collected from Fiscal Year 2008 pay scales
- There are 230 working days in a year.
- Civilian Pay Grade levels are GS13, GS14, and GS15.[43]
- Military Pay Grade levels are O-3, O-4, O-5, and O-6.[44]
- The market would pay 50% more for the outputs of the process, so a Market Comparables revenue multiplier of 1.5 is used.

[43] Salary Table 2008-GS. http://federaljobs.net/paytables/08gstbls.txt, (Accessed 29 February 2008).

[44] Military Basic Pay Table 2008. http://www.dfas.mil/militarypay/militarypaytables/2008MilitaryPayCharts35.pdf, (Accessed 29 February 2008).

- There is a lack of market forces in the non profit, which creates inefficiencies, so a 10% discount rate is used on the Market Comparable revenue.

2. Number of Employees

The "Number of Employees" category represents the number of government employees or contractors which are involved in the specific sub process. If more than one person was involved in both the parent and specific sub processes, that person is documented separately for each sub process.

3. Rank Order of Difficulty

An ordinal ranking of the relative difficulty of learning each of the processes is collected and used to ensure that the "Relative Learning Time" and "Actual Average Training Period" estimates are reliable. By allowing the subject matter experts to rank each of the sub processes (1 being the least complex) outside of the context of time units a correlation can be made between the "Rank Order of Difficulty" and the "Relative Learning Time." If a correlation of 80% is achieved the results appear to be reliable and the "Relative Learning Time" can be considered an accurate description of the relative difficulty of the sub processes. If a correlation of 80% is not achieved, the results must be closely scrutinized and the subject matter experts must be resurveyed and possibly given a more in-depth explanation of the concept of "Relative Learning Time."

4. Relative Learning Time

The "Relative Learning Time" category represents a distributed relative amount of 100 hours of learning time among the processes. "Relative Learning Time" assumes an "average person" will learn all he/she needs to know to successfully complete all the tasks in each process. This learning time estimate includes the time it would take to learn how to produce the same output that any automation (e.g. information systems) currently produces. The 100-hour learning period is distributed according to how difficult and

complex the processes are for the “average person” to learn. The purpose is to determine “Relative Learning Times” for each process given the 100-hour total. This helps identify the most complex processes and can be used as another internal reliability measure.

5. Actual Average Training Period

“Actual Average Learning Time” is what the actual average training time in hours is for the “average person” for each process. This would be for a new employee with no background who would be required to learn everything to produce the outputs of the given processes. Learning time includes both formal training and on the job training.

Results from “Relative Learning Time” and “Actual Average Learning Time” are also correlated. If a correlation of 80% is achieved the results appear to be reliable and the “Actual Average Learning Time” can be considered an accurate description of the “Relative Learning Time” of the sub processes. If a correlation of 80% is not achieved, the results must be closely scrutinized and the subject matter experts must be resurveyed and possibly given a more in depth explanation of the concept of “Relative Learning Time” along with “Actual Average Learning Time.” In some cases, subject matter experts may associate “Actual Average Learning Time” with a school or training period associated with the process. These schools and training periods are generally conducted over a uniform length of time and do not accurately reflect the “Actual Average Learning Time.”

6. Percentage Automation

Each sub process has a “Percentage Automation” associated with it between 0 and 100. This number captures the knowledge that is embedded in any information technology so that it can be accounted for in later calculations. This number represents the percentage of information technology that it utilized so that a process executor would not have to accomplish the task. For example, a process that has 100% automation would not require any process executors and would be accomplished fully by the automation tools listed for that process. If a process has 0% automation, no automation tools are

utilized and the process is totally executed by the process executors. These numbers are estimates based on subject matter expert's observations and experience. One basic assumption associated with this:

* "Replacement Technology," is automation that will reduce the number of process executors associated with the process without increasing the output of the process.

7. Times Performed in a Year

The "Times Performed in a Year" category represents the number of times each sub process is acted upon by a head process executor in a given year. The values were obtained by asking subject matter experts for their inputs to determine a valid estimate for the year long period.

8. Average Time to Complete

Each time a sub process is acted upon (as indicated in the "Times Performed in a Year" category) there is a specific amount of time that it takes for each sub process to be satisfactorily completed. This category represents the number of hours it takes a person trained in each process/sub process to complete each task.

9. Automation Tools

The "Automation Tools" category represents any tools such as MS Office, CMA, CENTRIX or Radio. This is used as a baseline for any automation tools that are already in use for the process and may provide insight for the implementation of other automation tools.

10. Total Learning Time (TLT)

This category is produced by dividing the "Actual Average Learning Time" by the "Percent Automation." Because we assume "replacement technology," the formula

used to determine TLT is “Actual Average Learning Time”/(1-“Percent Automation”). This provides a total time, in hours, for each process to include the learning time that is present in the automation tools. For example, if it takes one hour to learn a system that is 50% automated then the total learning time associated with the process is two hours, one hour associated with the process executors and one hour associated with the automation tools.

11. Total Knowledge

This category is a representation, in hours, of all of the knowledge for each process that occurs over the one year time frame in which the survey encompasses. The “Number of Employees” category is multiplied by the “Times Performed in a Year,” and the “Total Learning Time” categories.

12. Expenses

This number represents the costs that are associated with the government employees (civilian and military) associated with each process. This number is calculated by multiplying the “hourly wage” with the “Average Time to Complete,” and the “Times Preformed in a Year” categories. This number shows the cost of process only associated with personnel over the course of a year.

13. Revenue

This category represents the revenue generated by the process was executed by government employees. The “Revenue” category was calculated by multiplying the “Expenses” times a 1.5 multiplier (Based on the assumption the market would pay 50% more for the outputs of the process.) and a ten percent discount (Based on the assumption there is a lack of market forces in the non profit, which creates inefficiencies) for Market Comparable revenue.

14. Denominator

This category shows the cost associated with producing the output of each process. It is the same as the "Expense" category.

15. Numerator

The "Numerator" category is the "percentage of the revenue allocated to the amount of knowledge required to obtain the outputs of a given process in proportion to the total amount of knowledge required to generate the MDA "As Is" workflow's outputs."[45] For the purposes of this thesis, the revenue allocated to the amount of knowledge can be compared to the amount of knowledge that is present in each process or sub process. This can also be thought of as the total knowledge multiplied by the price of each common unit. This value was calculated by first finding the price of each common unit. The price per common unit (Revenue per Knowledge Unit) was calculated by dividing the "Total Knowledge" into the "Revenue." The "Numerator" was then calculated by multiplying the "Total Knowledge" associated with each sub process with the "Revenue per Knowledge Unit."

16. ROK

With each process or sub process there is both a cost and revenue associated with producing an output. The Return on Knowledge (ROK) provides a representation of how well the assets within a process are distributed in relation to one another by utilizing the costs and revenues associated with each sub process. The ROK is calculated by dividing the "Numerator" by the "Denominator." ROK's can be compared within a process to determine which processes are utilizing assets in an efficient manner and which processes need to be changed, perhaps by the utilization of automation tools, in order to improve efficiency. Although ROK is a very valuable tool, a low ROK does not dictate that a

[45] Housel, T. and A. Bell. Measuring and Managing Knowledge. 1st Ed. New York City: McGraw Hill, 2001.p 45.

process is in need of increased automation, but serves as an indicator that the process should be analyzed more closely to discover if process efficiency can be improved.

17. ROI

"ROI" or return on investment is a common accounting term that is widely understood by the financial community. For this reason, it is a slightly more meaningful number than "ROK." Essentially, it is a very similar number to "ROK," just a different unit of measure. In financial terms, "ROI" is the profit or loss resulting from an investment transaction, usually expressed as an annual percentage return. "ROI" is a return ratio that compares the net benefits of a project verses its total costs. In financial terms, "ROI" is calculated by profit minus investment all divided by investment. For the purposes of KVA, "ROI" is calculated by the "Numerator" minus the "Denominator" all divided by "Denominator." Much like "ROK's," "ROI's" can be compared within a process to determine which processes are utilizing assets in an efficient manner and which processes need to be changed, perhaps by the utilization of automation tools, in order to improve efficiency

Table 5 and 6 depict the MDA "As Is" workflow processes included in the KVA analysis. The MDA processes occur for one vessel which may potentially be boarded. Each process is audited to reveal the value added of knowledge assets meaning, derived from each process comprised of a particular number of employees and IT system components an ROK is computed as described above.

Process Description	Number of Employees	Title of Head Process Executer	Corresponding Pay Grades	Rank Order of Difficulty	Relative Learning Time (hrs)	Actual Average Training Period (hrs)	Percentage Automation	Times Performed In a Year	Average Time to Complete (hrs)	Automation Tools
Observe & Orient										
Generate Tip Intel: MARLO	10	Director	GS15	20	6	16	50%	17	40	N/A
Generate Tip Intel: CIFC	8	Director	O-5	21	6	16	50%	33	40	N/A
Generate Tip Intel: NCIS	40	Director	GS15	23	11	16	50%	50	40	N/A
Generate Tip Intel: ONI	40	Director	GS14	24	24	16	50%	200	40	CMA
Generate Tip Intel: INTL Maritime Bureau	10	Director	GS13	22	13	16	50%	33	40	N/A
Specify Credibility of Intel	14	attle Watch Capt (BWC	O-6	19	10	4	10%	333	2	N/A
Decide										
Receive and Route VOI	14	attle Watch Capt (BWC	O-4	13	3	4	10%	70	2	N/A
Process VOI: COPS Director or BWC	14	attle Watch Capt (BWC	O-4	17	3	8	20%	40	1	CENTRIX
Process VOI: FOPS	6	ONA Director	O-4	16	3	16	50%	30	10	CENTRIX
Assessment Tactical Assets Availability	14	attle Watch Capt (BWC	O-6	18	2	2	60%	100	2	N/A
Process/Issue RFI	6	ONA Director	O-6	19	2	4	80%	100	2	CENTRIX
Define Course of Action	14	MOC Director	O-6	3	3	6	10%	90	2	N/A
MOC-MOC Handoff (TO-BE)	14	MOC Director	O-6	14	3	1	80%	3	1	Radio
Communicate Mission Orders	14	attle Watch Capt (BWC	O-4	4	1	2	50%	90	1	Radio
Act										
Execute VBSS Mission: 5th Fleet	14	MOC Director	O-6	11	1	4	10%	150	6	N/A
Execute VBSS Mission: CFIC	8	CIFC Cdr	O-5	10	1	4	10%	50	6	N/A
Take Biometrics	10	Boarding Pty Leader	O-3	6	1	1	70%	400	4	N/A
Relay Biometrics	10	Boarding Pty Leader	O-3	5	1	1	80%	400	1	N/A
Analyze Biometrics	40	Director BFC in WV	GS15	7	1	1	80%	400	4	N/A
Analyze Boarding Data/Analyze Imagery/ Vessel Paramaters	40	ONA Director	O-6	8	1	1	80%	400	3	N/A
Take Boarding Data	10	Boarding Pty Leader	O-3	2	1	1	80%	400	2	N/A
Analyze Findings from ONI/Advise COPS	14	MOC Director	O-6	9	2	1	50%	400	2	N/A
Monitor VBSS Execution	14	MOC Director	O-6	1	1	1	60%	400	24	N/A

Table 6. MDA Process Audit

Process Description	TLT	Total Knowledge	Expenses	Revenues	Denominator	Numerator	ROK	ROI
Observe & Orient								
Generate Tip Intel: MARLO	32	533	$ 30,642.23	$ 41,367.01	$ 30,642.23	$ 36,522.44	119%	19%
Generate Tip Intel: CIFC	32	1067	$ 61,284.46	$ 82,734.02	$ 61,284.46	$ 73,044.88	119%	19%
Generate Tip Intel: NCIS	32	1600	$ 91,926.68	$ 124,101.02	$ 91,926.68	$ 109,567.33	119%	19%
Generate Tip Intel: ONI	32	6400	$ 367,706.74	$ 496,404.09	$ 367,706.74	$ 438,269.30	119%	19%
Generate Tip Intel: INTL Maritime Bureau	32	1067	$ 61,284.46	$ 82,734.02	$ 61,284.46	$ 73,044.88	119%	19%
Specify Credibility of Intel	4	1480	$ 30,611.59	$ 41,325.64	$ 30,611.59	$ 101,349.78	331%	231%
Decide								
Receive and Route VOI	4	311	$ 6,434.87	$ 8,687.07	$ 6,434.87	$ 21,304.76	331%	231%
Process VOI: COPS Director or BWC	10	400	$ 1,838.53	$ 2,482.02	$ 1,838.53	$ 27,391.83	1490%	1390%
Process VOI: FOPS	32	960	$ 13,789.00	$ 18,615.15	$ 13,789.00	$ 65,740.40	477%	377%
Assessment Tactical Assets Availability	5	500	$ 9,192.67	$ 12,410.10	$ 9,192.67	$ 34,239.79	372%	272%
Process/Issue RFI	20	2000	$ 9,192.67	$ 12,410.10	$ 9,192.67	$ 136,959.16	1490%	1390%
Define Course of Action	7	600	$ 8,273.40	$ 11,169.09	$ 8,273.40	$ 41,087.75	497%	397%
MOC-MOC Handoff (TO-BE)	5	15	$ 137.89	$ 186.15	$ 137.89	$ 1,027.19	745%	645%
Communicate Mission Orders	4	360	$ 4,136.70	$ 5,584.55	$ 4,136.70	$ 24,652.65	596%	496%
Act								
Execute VBSS Mission: 5th Fleet	4	667	$ 41,367.01	$ 55,845.46	$ 41,367.01	$ 45,653.05	110%	10%
Execute VBSS Mission: CFIC	4	222	$ 13,789.00	$ 18,615.15	$ 13,789.00	$ 15,217.68	110%	10%
Take Biometrics	3	1333	$ 73,541.35	$ 99,280.82	$ 73,541.35	$ 91,306.10	124%	24%
Relay Biometrics	5	2000	$ 18,385.34	$ 24,820.20	$ 18,385.34	$ 136,959.16	745%	645%
Analyze Biometrics	5	2000	$ 73,541.35	$ 99,280.82	$ 73,541.35	$ 136,959.16	186%	86%
Analyze Boarding Data/Analyze Imagery/ Vessel Paramaters	5	2000	$ 55,156.01	$ 74,460.61	$ 55,156.01	$ 136,959.16	248%	148%
Take Boarding Data	5	2000	$ 36,770.67	$ 49,640.41	$ 36,770.67	$ 136,959.16	372%	272%
Analyze Findings from ONI/Advise COPS	2	800	$ 36,770.67	$ 49,640.41	$ 36,770.67	$ 54,783.66	149%	49%
Monitor VBSS Execution	3	1000	$ 441,248.08	$ 595,684.91	$ 441,248.08	$ 68,479.58	16%	-84%
Totals	288	29315	$ 1,487,021.36	$2,007,478.84	$ 1,487,021.36	$ 2,007,478.84	135%	35%

Revenue per Knowledge Unit: $ 68.48

Pay Grade	Average Base Pay	Hourly Wage	Assumptions
O-3	$ 62,141.73	$ 33.77	Expenses consist of Personnel Costs.
O-4	$ 71,340.55	$ 38.77	There are 230 working days in a year.
O-5	$ 81,238.42	$ 44.15	Civilian Pay Grade levels are GS13, GS14, and GS15.
O-6	$ 95,409.65	$ 51.85	The market would pay 50% more for the outputs of the process, so a Market Comparables
GS13	$ 78,921.00	$ 42.89	revenue multiplier of 1.5 is used.
GS14	$ 93,256.50	$ 50.68	There is a lack of market forces in the non profit, which creates inefficiencies, so a 10% discount
GS15	$ 109,700.00	$ 59.62	rate is used on the Market Comparable revenue.
AVG	$ 84,572.55	$ 45.96	

Table 7. MDA Process Audit (Continued)

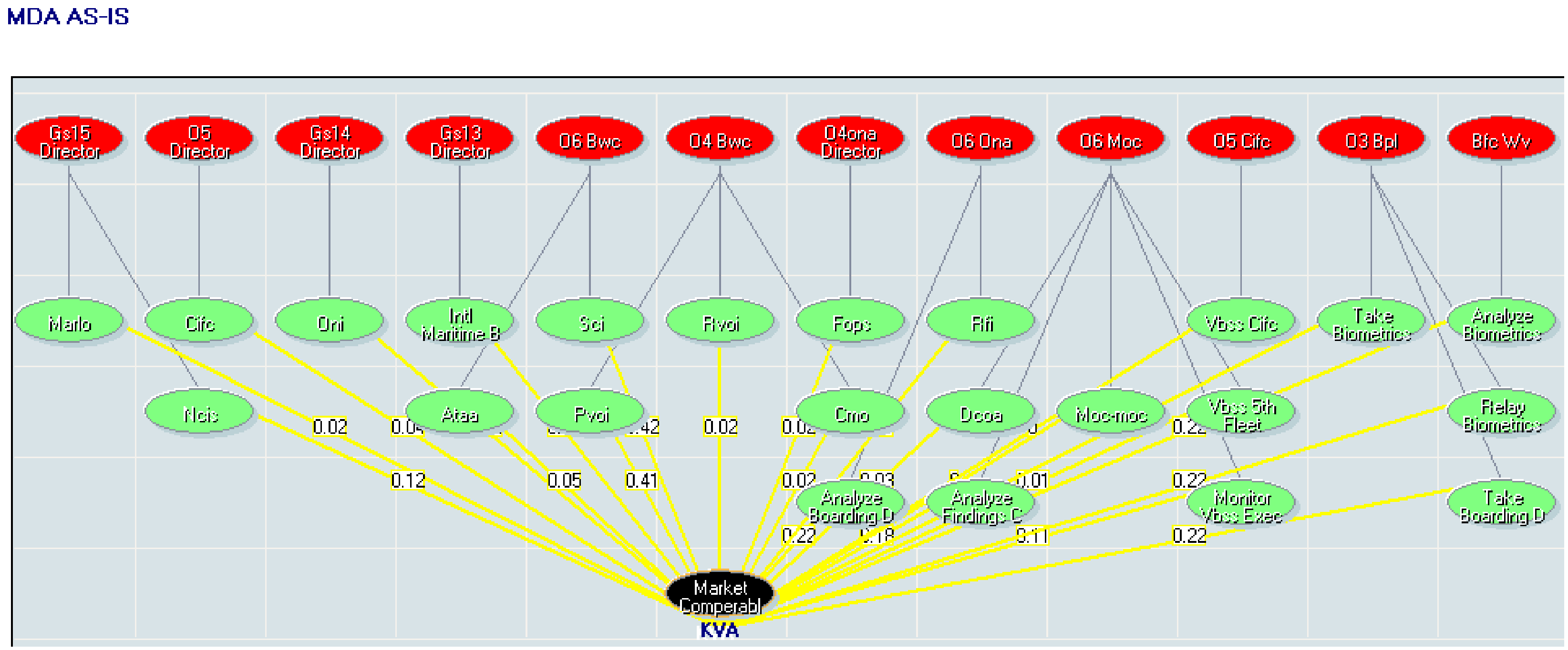


Figure 17. GaussSoft – MDA "As Is" Workflow KVA Analysis

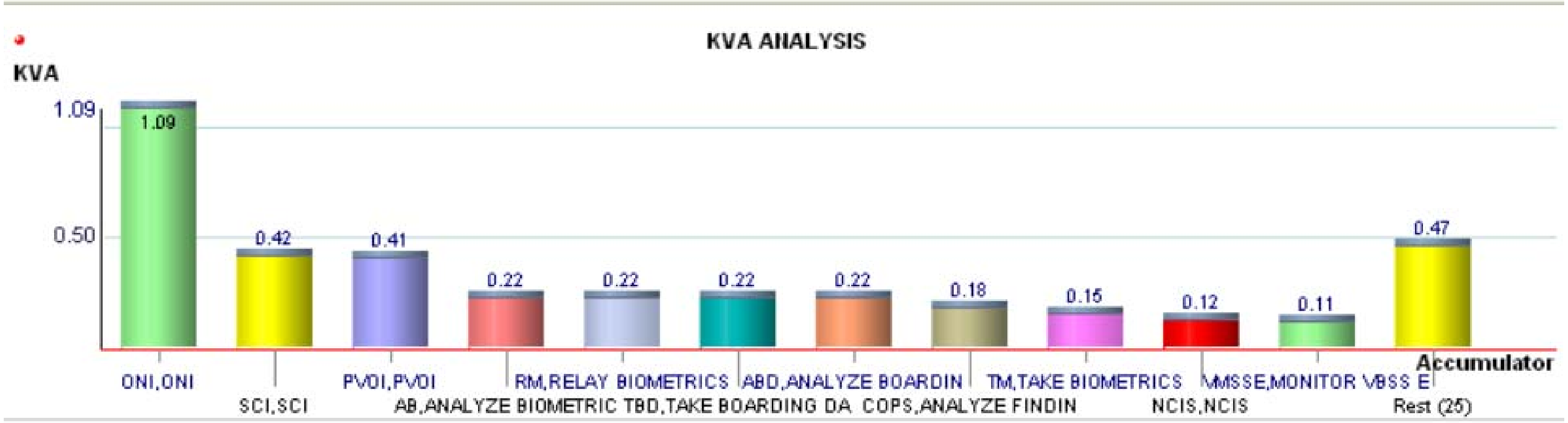


Figure 18. GaussSoft – MDA "As Is" Workflow KVA Analysis

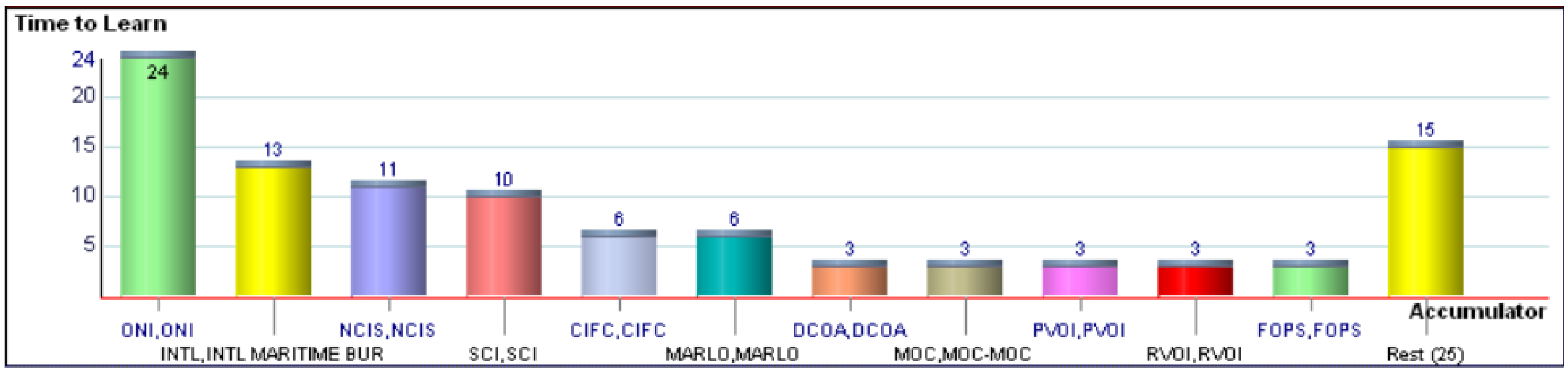


Figure 19. GaussSoft – MDA "As Is" Workflow Time to Learn

Year	2008				
Accumulator	Output (KVA)		KVA	Time to Learn	Automation (%)
ANALYZE BIOMETRICS	9.55%	400	0.2283	1	80
ANALYZE BOARDING DATA	9.55%	400	0.2283	1	80
ANALYZE FINDINGS COPS	9.55%	400	0.1826	2	50
ATAA	2.39%	100	0.0571	2	60
BFC WV		0	0.0000	0	
CIFC	0.79%	33	0.0452	6	50
CMO	2.15%	90	0.0205	1	50
DCOA	2.15%	90	0.0342	3	10
FOPS	0.72%	30	0.0205	3	50
GS13 Director		0	0.0000	0	
GS14 Director		0	0.0000	0	
GS15 Director		0	0.0000	0	
INTL MARITIME BUREAU	0.79%	33	0.0979	13	50
MARKET COMPERABLES		0	0.0000	0	
MARLO	0.41%	17	0.0233	6	50
MOC-MOC	0.07%	3	0.0051	3	80
MONITOR VBSS EXECUTION	9.55%	400	0.1142	1	60
NCIS	1.19%	50	0.1256	11	50
O3 BPL		0	0.0000	0	
O4 BWC		0	0.0000	0	
O4ONA DIRECTOR		0	0.0000	0	
O5 CIFC		0	0.0000	0	
O5 Director		0	0.0000	0	
O6 BWC		0	0.0000	0	
O6 MOC		0	0.0000	0	
O6 ONA		0	0.0000	0	
ONI	4.77%	200	1.0959	24	50
PVOI	0.95%	40	0.4110	3	20
RELAY BIOMETRICS	9.55%	400	0.2283	1	80
RFI	2.39%	100	0.1142	2	80
RVOI	1.67%	70	0.0266	3	10
SCI	7.95%	333	0.4224	10	10
TAKE BIOMETRICS	9.55%	400	0.1522	1	70
TAKE BOARDING DATA	9.55%	400	0.2283	1	80
VBSS 5TH FLEET	3.58%	150	0.0190	1	10
VBSS CIFC	1.19%	50	0.0063	1	10
TOTAL	100%	4,189	3.8872	100	1,140

Table 8. GaussSoft –MDA “As Is” Workflow Output Spreadsheet

F. CONCLUSION

In summary, at the conclusion of the MDA "As Is" workflow model Process 280, the general assumption could be made that the OODA Loop cycle restarts at the Orient phase and continues through the workflow model again as before. Also, the assumption can be made that it potentially could restart before reaching the final process of the MDA "As Is" workflow model, given the circumstance that a boarding is not required. Theoretically, applying the phases of the OODA Loop tactically and proficiently, the warfighter will get into the OODA Loop of an opponent, meaning the warfighter can out-think the opponent. When the warfighter can achieve getting into the OODA Loop of an opponent, the warfighter can attain dominance over the opponent's command and control structure; thus leveraging his or her military power. In other words, out-thinking an opponent is the power of methodically executing the OODA Loop phases.

Core net-centric capabilities, supported by OA technology and software, enable the fluid processing of flowing streams of continuous data that sustain accurate updates to VOI information to be fed and fused into a coherent common operating picture (COP), providing improved analytical and collaboration tools. This MDA "As Is" workflow model appears to contain the concepts of collaboration, information sharing, reuse, and other OA tenets that would make it an approach with plenty of knowledge assets.

GaussSoft KVA software that was utilized to extract an array of KVA data input: Cost of Employees, Revenues, Total Learning Time, Percentage Automation, and Times Performed in a Year. A predetermined set of Outputs (such as the processes listed under the Observe & Orient, Decide, and Act phases), were used to make a baseline assessment, in analyzing the economic performance and cost-benefit relation associated with the MDA operational processes.

In Figure 18, there is a profitability model created with GaussSoft KVA software for the MDA process. The resources contained the knowledge to produce outputs. Time to Learn describes the amount of time it takes an average person (Head Process Executer) to learn a process. The Time to Learn Model indicates 24 hours for ONI, 13 hours for Intl Maritime Bureau, 11 hours for NCIS, 10 hours for SCI, 6 hours for CIFC, 6 hours

MARLO, 3 hours for DCOA, 3 hours for MOC-MOC, 3 hours for PVOI, 3 hours for RVOI, 3 hours for FOPS, 15 hours for the rest of the total processes as shown in Figure 20. So an average MDA Head Process Executer would take longer to learn the ONI portion of the MDA "As Is" process in order to execute it properly. It takes less time to learn Data Acquisition.

The KVA model indicates ONI of 1.09, SCI of 0.42, PVOI of 0.41, Analyze Biometric of 0.22, Relay Biometric of 0.22, Take Boarding Data of 0.22, Analyze Boarding of 0.22, Analyze Finding of 0.18, Take Biometrics of 0.15, NCIS of 0.12, and Monitor VBSS Execution of 0.11, as shown in Figure 19. Even though ONI takes a longer time to learn, it returns a higher value of knowledge using KVA methodology.

Overall thesis conclusions and recommendations for follow-on research are found in Chapters VII and VIII.

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VII. CONCLUSIONS AND RECOMMENDATIONS

Performing routine business process auditing, providing additional implementation of OA technology and conducting knowledge asset management appears essential to putting forth best efforts of attaining complete maritime domain awareness. Utilizing KVA software tools like GaussSoft to assist decision-makers in performing business process auditing is an ideal strategy for conducting near real-time assessment of the value of knowledge assets and process efficiency. This thesis answers the research questions stated in Chapter 1.

What can be gleaned from collecting performance data on an ongoing basis that would be valuable to the MDA process flow? Per Table 6, the ROK and ROI for all MDA “As Is” workflow processes with the exception of “Monitor VBSS Execution” are positive; therefore indicates that overall significant value is added to the organization by both human and IT knowledge assets. Also, the ROI values suggest that significant efficiency is achieved for the majority of the processes.

While using OA, what portion of the MDA “As Is” workflow model provides the best means of employing MDA knowledge assets based on their performance? Per Chapter 6, Table 6, the best means of employing MDA knowledge assets, based on their performance, is within the “Decide” phase of the OODA Loop for the MDA “As Is” workflow. In both ROK and ROI calculations, there appears to be greater KVA and efficiency than found in any other phase of the OODA Loop.

What is the baseline measurement of KVA and ROI of the MDA “As Is” workflow model? In Chapter 6, Tables 5 and 6 represent the baseline measurement of KVA and ROI of the MDA “As Is” workflow model. As previously stated, these tables are based entirely on survey input from subject matter experts and notional data to provide the best estimates for this model.

Are people and equipment being used in such a manner as to maximize output efficiency and performance? Because this thesis only covers the “As Is” state of the MDA workflow model, there is no current comparative analysis to determine what the

maximum output efficiency and performance could be. In future research, this should be explored. Nevertheless, the process audit revealed, as computed in Table 5, all process and sub-process have positive ROK values ranging from 16% to 1490% and ROI values ranging from -84% to 1390% and is currently the baseline metrics to compare against the "To Be" model in future research.

This thesis implemented GaussSoft KVA software within MDA "As Is" process flow model to reveal value added and ROI. The results show that GaussSoft is an effective metric tool from which decision makers can leverage military power, by gaining comprehension of their knowledge assets as resources.

VIII. FUTURE RESEARCH

This thesis assessed the MDA "As Is" workflow model implementing OA technology using GaussSoft KVA software to determine the baseline value added of its knowledge assets. A baseline has been set in this research for the value of integrating OA into the MDA SPIRAL 1 workflow processes. There is still much research that can be conducted to evaluate the benefit of OA in the Maritime Domain environment.

A great possibility exists to explore the impact of OA in the future MDA "To Be" workflow model. This research reinforced the fact that MDA processes benefit from OA by enabling personnel reductions and decreased OODA Loop cycle time via process automation. These benefits allow decision-makers to collaborate in performing the processes that accomplish each phase of the OODA Loop. By efficiently stepping through each phase and effectively out-thinking an adversary, in theory, can enable U.S and its coalition partners to realize the goal of complete MDA. This topic could present an area for future research.

Lastly, data capturing methods could be put into place to provide historical data inputs along with subject matter expert (SME) inputs which would support future research with a readily available documented source of research data; reducing the need for notional data and enabling better estimates. Also, a standard source of market comparables for not for profit organizations in the form of a table or reference guide would help establish more accurate and or meaningful analysis. The potential for increased efficiency in this process should not be overlooked and would provide an area for further research. Another area for future research could employ business process reengineering (BPR) to the MDA workflow process model.

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APPENDIX A. SURVEY

NAVAL POSTGRADUATE SCHOOL
MONTEREY, CA

MDA WORKFLOW ANALYSIS:
AN ASSESSMENT AND COMPARISON OF ROI IN CURRENT AND FUTURE PROCESSES

Dr. Thomas Housel

Associate Professor
Naval Postgraduate School

Yaara Bergin

Research Associate
Naval Postgraduate School

TABLE OF CONTENTS

GOAL

The aim of this study is to analyze NAVCENT's MDA core processes. It will establish a baseline "AS-IS" environment model and compare it to notional environments representing the added capabilities of Spiral-1 technologies. Hopefully, this analysis will help lead to enhanced decision making, based on quantifiable data related to improving the process.

REQUIREMENTS

Please complete the attached template (template.xls) Depending on the respondent(s) understanding of the processes, the whole template can be completed in 1.5 hours, or less.

Instructions for completion of the templates, including detailed descriptions of how to fill in the blanks, are provided below. If necessary, we will help the participants complete this template via a meeting or phone interview

Please answer to the best of your ability in your areas of expertise or in the areas in which you feel most comfortable answering. Only rough estimates are necessary, so please do not waste your time attempting to answer perfectly.

PRELIMINARY INFORMATION

Please fill in the following on the attached Template (for a screenshot of the template, please refer to *Figure A* on the next page), in the allotted spaces *(All individual responses will remain anonymous)*:

Name:

Please provide your name.

Government Pay Grade:

Please enter your government pay grade. If you are a contractor, please estimate the equivalent government pay grade for the position in which you serve. If you cannot make such an estimate, enter "N/A."

Job-Title:

Please enter your job title.

Job Description:

Please provide a brief job description.

FIGURE A

Process Description	Title of Head Process Executer	Number of Employees	Corresponding Pay Grades	Rank Order of Difficulty	Relative Learning Time	Actual Average Training Period	Percentage Automation	Times Performed In a Year	Average Time to Complete	Automation Tools	Notes/ Comments
OBSERVE AND ORIENT											
Generate Tip Intel											
MARLO											
CIFC											
NCIS											
ONI											
INTL Maritime Bureau											
Specify Credibility of Intel											
DECIDE											
Receive and Route VOI											
Process VOI											
COPS Director or BWC											
FOPS											
Assessment Tactical Assets Availability											
Process/Issue RFI											
Define Course of Action											
MOC-MOC Handoff (TO-BE)											
Communicate Mission Orders											
ACT											
Execute VBSS Mission											
5th Fleet											
CFIC											
Take Biometrics											
Relay Biometrics											
Analyze Biometrics											
Analyze Boarding Data/Analyze Imagery/Vessel Paramaters											
Take Boarding Data											
Analyze Findings from ONI/Advise COPS											
Monitor VBSS Execution											
General Comments											

TEMPLATE INSTRUCTIONS

Please read all instructions below before completing.

Please note that the MDA workflow has been aggregated into three main processes, and each of these has been broken down into additional sub-processes (a few of the sub-processes have been further developed, to show that multiple agents perform the same task). These processes flow in sequential order. If you believe a process is missing, inaccurate, or improperly named, please make a comment in the “General Comments” section of the template, but complete the survey as it currently is. Please pay special attention to these instructions.

Detailed instructions for each column are presented below, as well as posted as comments on the column headers of the attached template (hover your mouse over each column header to see its corresponding comment):

Title of Head Process Executer

Please provide the title given to the head in charge of each process (e.g., Technology Director).

Number of Employees

An estimate of the total number of employees working in each area should be provided.

Corresponding Pay Grades:

Please provide a range of the government pay grades corresponding to the number of employees involved in each process. Please be as detailed as possible.

Rank Order of Difficulty

Please rank order the three processes (Observe and Orient, Decide, and Act) in terms of their difficulty to learn (1=easiest, 3=hardest). Once this has been completed, please rank order the 17 sub-process (e.g. Generate Tip Intel, Specify Credibility of Intel), as well (1=easiest, 17=hardest) *Remember, please complete the entire column to the best of your ability; rough estimates are sufficient.*

Learning time *(Explanation of next two categories)*

The learning time is the time it takes an "average person" to learn how to successfully complete all the tasks in a process, including how to manually perform all the tasks that are currently automated (e.g. information systems). The "average person" would be a new employee, with no prior experience. Make sure to keep in mind the same employee for all your estimates for *all the* processes. Educational background above and beyond what a job requires is not included. For example, the learning time of a Ph.D. performing the job of a secretary would be the same as that of the average secretary, because the estimate does not include all of his/her education; It equals the time to learn all duties of a secretary, i.e., only the time to learn how to perform the secretary's job correctly. The end result of the "average person" performing all the tasks in a given process should be the output of that process. Please use the same reference person for all process estimates.

Please note two important items:

- The time it takes to learn to perform a task is **not** the same thing as the time it takes to perform a task.
- The learning time estimates **do not** equal the cost of training.

Relative Learning Time

Please distribute a relative amount of 100 hours of learning time among the three core processes (Observe and Orient, Decide, and Act). Distribute the 100-hour learning period according to how difficult and complex the areas are for the “average person” to learn. The most difficult tasks to learn (not necessarily to do) would take a higher percentage of the 100-hour learning period than an easier task to learn. The purpose is to determine relative learning times for each area, given the 100-hour total.

Once this has been completed, please distribute the hours of each process among its corresponding sub-processes. (As an example, if Process A takes 20 hours to learn, and has four sub-processes, you would then appropriately distribute the 20 hours among Sub-Process 1, Sub-process 2, Sub-Process 3, and Sub-Process 4.)

Please note the following:

- When all the hours for the process are summed, they should equal 100.
- If another time interval (such as minutes, days, months, etc.) makes more sense than “hours,” then feel free to use one of the other intervals, but please make sure to stay consistent for *all*

processes and sub-processes, and that the time intervals still sum up to 100 units of your selected learning time measure.

- Please remember that rough estimates are sufficient for estimation purposes.

Average Actual Training Period

Please indicate what the **actual** average training time in hours (or other unit of time if a different learning time unit makes more sense to you) is for the "average person" for each *sub-process*.

Percentage Automation

Please give an estimate of the percentage of automation in the core processes and sub-processes.

Times Performed in a Year

Please provide the estimated number of times that each process is performed by all employees working in the process area to generate the process output in a given year. For example, 10 employees may need to work to generate one output from process A per month. In this case, the number of outputs (and the number of times the process is performed in a year) would be 12 per year.   In another case, 5 employees may each produce one output for process B each month. In which case, the number of process outputs per year for B would be 12 months times 5 outputs per month or 60 process B outputs per year.

Average Time to Complete

Please provide the estimated time it takes a person trained in each process/sub-process to complete each task.

Automation Tools

Please list the automation tools that aid in completion of each process.

Notes/Comments

Please feel free to make any notes or comments regarding your methodology or reasoning for making a given entry.

General Comments

Use this field to provide any general comments that don't apply specifically to the processes above. For instance, if you feel that there is a missing or improperly named process, please comment on that here and provide the requisite information so we can correct the survey.

COMPLETION EXAMPLE

Below is a completed survey example of the first row from a previous study. Please refer to *Figure B*, on the next page to view how it looks on the spreadsheet.

Title of Head Process Executer: Technology Director

Number of Employees: 5. Five people work on this process.

Corresponding Pay Grades: 3 GS-9s, 2 GS-11s. There are three employees with the pay grade GS-9 and two employees with the pay grade GS-11.

Rank Order of Difficulty: 17. This process is the hardest process to learn.

Relative Learning Time: 20 hours. About 1/5 the time spent to learn all of the processes should be devoted to this process. So out of 100 hours, 20 should be spent learning process 250.2 (20).

Actual Average Training Period: 155. In actuality, it takes the average reference point learner about 155 hours to learn this process.

Percentage Automation: 30%. The project team uses some advanced software to complete their process, so about 30% of the process is automated. In this case, the automation does not change the characteristics of the process output. In some cases, the automation provides new additions to the process output. This issue will come into play when we move from the baseline “as-is” process analysis to the “to-be” analysis where new technology will be used in the processes and in some cases will provide added outputs that were not part of the baseline process output.

Times Performed a Year: 25. This process occurs about 25 times a year.

Average Time to Complete: 200 hours. On average it takes about 200 hours to complete this process.

Automation Tools: NDE (Navy Data Environment). This process uses NDE (please specify what it does in terms of producing new outputs, if any).

FIGURE B

Sub-Process	Title of Head Process Executer	Number of Employees	Corresponding Pay Grades	Rank Order of Difficulty	Relative Learning	Actual Learning Time	% Automation	Times Performed	Average Time to Complete (Hours)	Automation Tools
10 Submit Ship Change Document										
170.1 Develop Supporting Documentation, Equipment Specifications, and class/system integration requirements	Technology Director	5	3 GS-9s, 2 GS-11s	13	20	155	30%	25	200	NDE
170.2 Determine applicable ship/class/site/flight unique characteristics										
170.3 POA&M is required for equipment development and complete SCD										
200 Update CBA										
265.1 Develop ship specific documentation as required to install the SCD on a specific ship										
265.2 Conduct a hull installation readiness review										
265.3 Evaluate results of installation readiness review.										
265.4 Assess and evaluate the risk of a proposed installation on a specific										
265.4.1 Formally propose an installation for hull readiness assessment and installation authorization										
265.5 Determine and weigh the operational risks (if any) associated with the installation of a SC on a specific hull.										
310 Provide feedback data to support future installation decisions										
320 Using feedback information from completed installs, determine impact on follow-on installs.										

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Thank you very much for your participation.

APPENDIX B. WORK FLOW MODEL

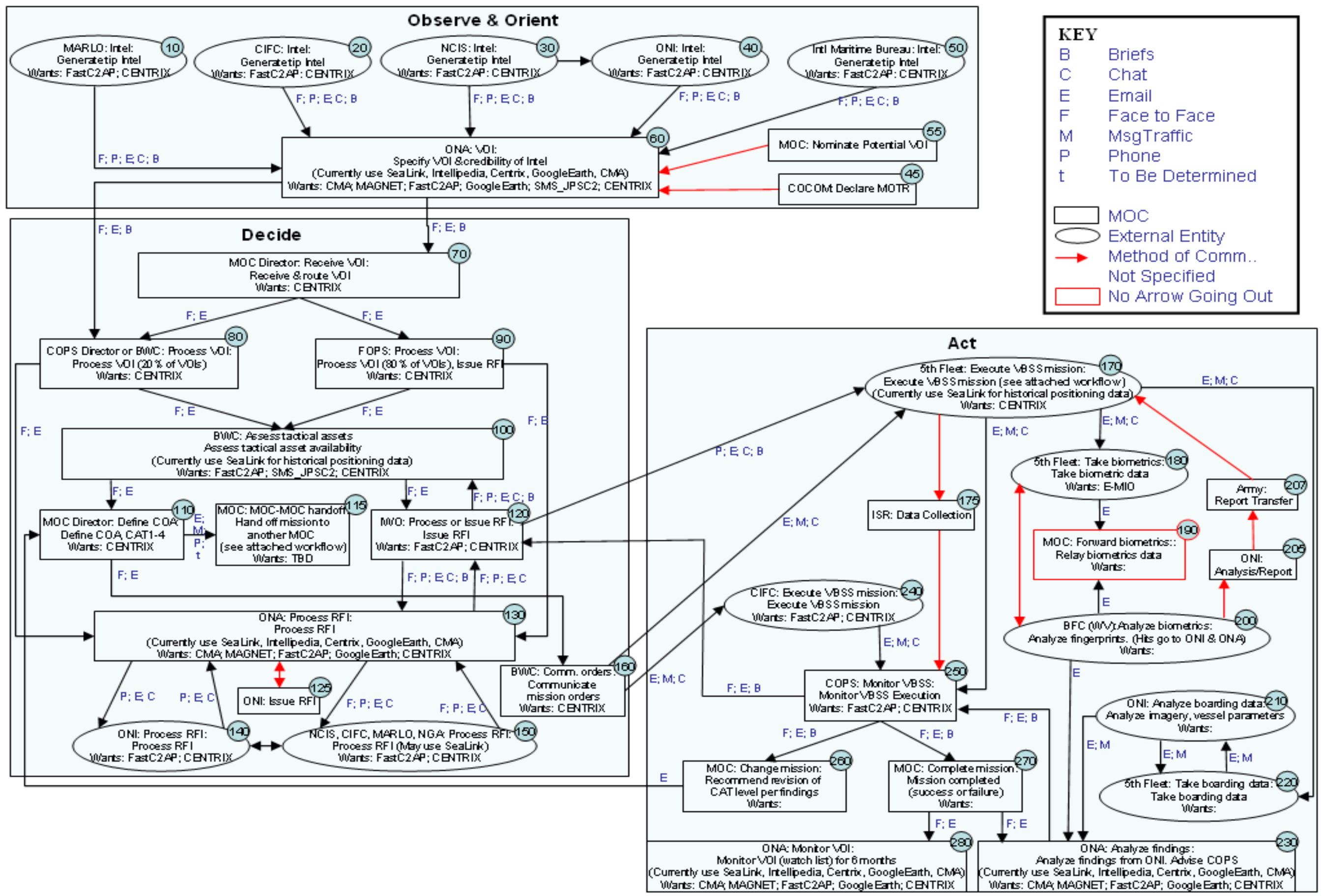

Figure 20. MDA “As Is” Work Flow Model

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APPENDIX C. BOARDING PROCESS

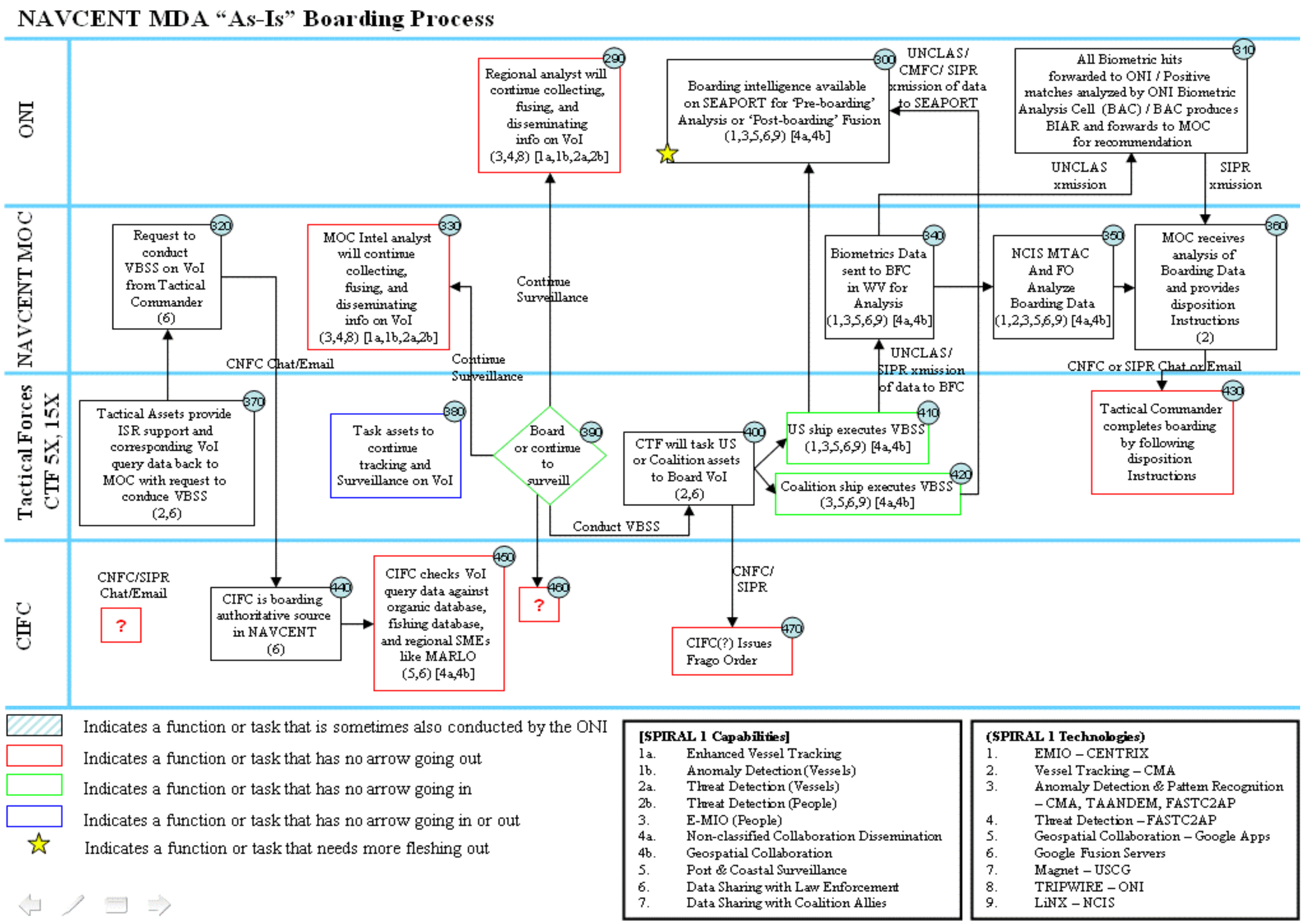

Figure 21. NAVCENT MDA “As Is” Boarding Process

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APPENDIX D. TRACK & SURVEILLANCE

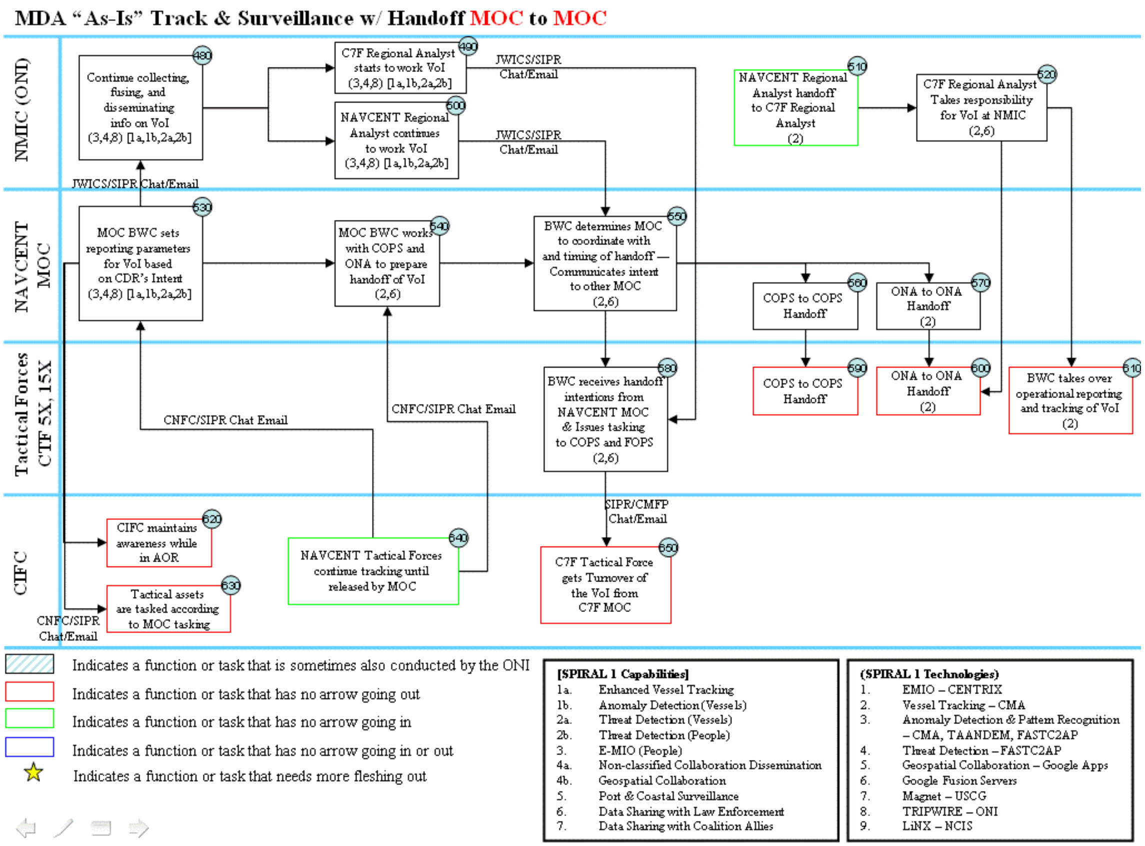

Figure 22. MDA "As Is" Track & Surveillance w/ Handoff MOC to MOC

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